THE

JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

VOL. XVIII. No. 438—21st YEAR.] LONDON, AUGUST 3, 1869. [Subscription per Ann. { 15s. in Advance / 18s. Credit.] DOUBLE No. Price 1s.

RAMSAY'S NEWCASTLE CANNEL
COAL. Analysis—
10,000 cubic feet of gas per ton of coal.
26-candle gas.
13½ cwt. coke per ton of coal.
RAMSAY'S PATENT CONDENSED COKE.
DO. GARESFIELD COKE.

RAMSAY'S FIRE-CLAY ARTICLES.
GAS-RETORTS, introduced 1823.
FIRE-BRICK WORKS, established 1804.
FIRE-CLAY SANITARY PIPES, CHIMNEY-TOPS, and all Goods made of Fire Clay.
The Fire Clay is worked from Blaydon Main Colliery, is of excellent quality, and no expense spared in perfecting every article.
The FIRE-BRICKS (marked "RAMSAY") are to be seen in all parts of the world, and the works are the most extensive in the Kingdom.
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Address G. H. RAMSAY, NEWCASTLE-ON-TYNE.

GEORGE GLOVER & CO.,
Patentees of the Standard Gasometers for the Government, and of the
IMPROVED DRY GAS-METERS.
These Meters are warranted to measure correctly and not to vary, and have come into general use more rapidly than any Meters hitherto manufactured.

PARIS EXHIBITION, 1867.
THE TESTING-HOUSE REPORTS.
The Reports prepared for the Science and Art Department, under the direction of the Lords of the Council, detail the arrangements made for testing the gas apparatus exhibited. In the testing-house erected by the Special Committee appointed to further this object a gasholder was constructed by Mr. G. Glover, being a *fac simile* of that produced and patented by him in 1860, and deposited in the Exchequer, under the provisions of the Sales of Gas Act, and British manufacturers of gas apparatus were invited by advertisement, and by direct application, to forward worthy objects for exhibition. Mr. G. Glover was, however, the only manufacturer who sent Meters to be tested. The report states that, as "Mr. Glover is a manufacturer of Dry Meters only, no opportunity presented itself of comparing their accuracy with that of Wet Meters under various circumstances, but the perfection to which that maker has brought his Meters prevents the possibility of those extravagant errors which are well known to exist where Wet Meters are used."
Particulars and lists of prices forwarded on application to Ranelagh Works, Ranelagh Road, Pimlico, LONDON, S.W.; 15, Market Street, MANCHESTER; or 97, Boulevard de Magenta, PARIS.

COWEN'S PATENT FIRE-CLAY RETORTS.
JOSEPH COWEN and CO.,
BLAYDON BURN, NEAR NEWCASTLE-ON-TYNE,
Were the only parties to whom a PRIZE MEDAL was awarded at the GREAT EXHIBITION of 1851, for "GAS RETORTS and OTHER OBJECTS in FIRE-CLAY," and they have also been awarded in the INTERNATIONAL EXHIBITION of 1862, the PRIZE MEDAL for "GAS RETORTS, FIRE-BRICKS, &c., for EXCELLENCE of QUALITY."
J. C. and Co. have been for many years the most extensive Manufacturers of Fire-Clay Retorts in the United Kingdom; and orders for Fire-Clay Retorts of all shapes and dimensions, Fire-Bricks, and every other article in Fire-Clay are promptly executed at their Works as above.
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Coal Office,
QUAY SIDE, NEWCASTLE-ON-TYNE.

FIRST PRIZE IN THE PARIS EXHIBITION.

JOHN RUSSELL AND CO.,
THE OLD TUBE WORKS,
CHURCH HILL, WEDNESBURY;
ALMA WORKS,
WALSALL, STAFFORDSHIRE;
and 69, UPPER THAMES STREET, LONDON,
Original Manufacturers of Wrought-Iron Gas Tubes and Holders of the present Patents; Inventors and First Makers of LAP-WELDED FLUES for Steam Boilers.
J. R. and Co. make all kinds of Tubes and Fittings for Gas, Steam, and Water, and the largest Orders may be executed in a few days.
Gun Metal, and all other kinds of Cocks, Stocks, Dies, and Taps, Galvanised Tubes, &c.
N.B. All Goods thoroughly Tested before sent out, and Warranted.

JOHN BENT & SON,
WET AND DRY GAS-METER
AND
STREET-LAMP
MANUFACTURERS,
BELL BARN ROAD, BIRMINGHAM.
ESTABLISHED 1830.
All materials found for the alteration of Public Lamps for lighting with the Rod. Regulators with Lava Burners.

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NEAR NEWCASTLE-ON-TYNE.
WILLIAM COCHRAN CARR begs most respectfully to thank the Metropolitan, Provincial, and Continental Gas Companies for their patronage for several years past, and to intimate that he has rebuilt and enlarged his extensive premises for the manufacture of CLAY RETORTS; and that he is now prepared to execute the largest orders with punctuality and despatch. Orders for FIRE-CLAY RETORTS, of all shapes and sizes, FIRE-BRICKS, and all other articles in Fire-Clay, executed on the shortest notice, and on the most reasonable terms.
London Agents: JAMES LAWRIE & CO.,
63, OLD BROAD STREET, CITY, LONDON.

THE "LOTHIAN" CANNEL COALS.
These Cannels are extensively used in the Gas-Works of Edinburgh, where the illuminating power of the gas is the highest in Britain.
The yield per ton is 12,573 cubic feet; illuminating power 33·8 standard candles; coke per ton 1046 lbs.
Ports of Shipment, in the Firth of Forth.

BO'NESS CANNEL COALS.—This Cannel is largely used in gas-works where, in addition to high illuminating power, there exists a demand for superior Coke, it being the best Coke-producing Cannel of all Scottish Cannels. It yields about 11,000 cubic ft. of 25 standard candle gas per ton.
Ports of Shipment, either the Forth or the Clyde.
Apply to J. and W. ROMANS, 53, Frederick Street, EDINBURGH; & 1, Walbrook, Mansion House, LONDON.

NOTICE.
LESMAHAGO GAS OR CANNEL COAL.
JAMES FERGUSON & CO., Auchinheath Colliery, Lesmahago, and the NITSHILL & LESMAHAGO COAL COMPANY, Auchinheath and Southfield Collieries, Lesmahago, sole Proprietors and Producers of the above celebrated GAS COAL, beg to intimate to Gas Companies and other consumers that, having reason to suspect that Cannel or other Coal of very inferior quality, both as regards the quantity and illuminating power of the Gas, has frequently been mixed with and sold under the name of "Lesmahago," they have now appointed Messrs. JAMES LAWRIE & Co., of 63, Old Broad Street, LONDON, E.C., sole agents for England; and Messrs. LA COUR & WATSON, of LEITH, sole agents for foreign markets; and, in order to prevent a recurrence of the frauds named, they request that all purchasers will send their orders through the above-named firms. Orders for other than the above-named markets may be forwarded direct to either of the Proprietors.
The Proprietors will, in future, use their own forms of bills of lading, and also issue certificates of origin, signed, as the case may be, either by JAMES FERGUSON & Co., or by the NITSHILL & LESMAHAGO COAL COMPANY; and they request all consumers purchasing Lesmahago Coal to demand such a certificate for each cargo, and to observe that it corresponds with the bill of lading.
Auchinheath, Lesmahago, March, 1868.

MEDAL AWARDED, EXHIBITION, 1862, "FOR GOOD WORK."
THE IMPERIAL TUBE COMPANY, BIRMINGHAM,
MANUFACTURERS OF
WROUGHT-IRON TUBES & FITTINGS, BRASS & COPPER TUBES,
GALVANIZED & GLASS ENAMELLED TUBES & FITTINGS,
LAP-WELDED IRON & BRASS BOILER-TUBES, ETC., ETC.
☞ Sole Makers of "HUGHES'S PATENT TAPS," Strongly recommended for all High-pressure purposes.—Price List and Testimonials forwarded on application.

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PRIZE MEDALS. (INVENTED & PATENTED IN 1844,) PRIZE MEDALS.
LONDON, 1851; NEW YORK, 1853; PARIS, 1855. COMBINING ALL THE LATEST IMPROVEMENTS, LONDON, 1862; DUBLIN, 1865; PARIS, 1867.
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THE GAS-METER COMPANY, LIMITED.
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A. ANGUS CROLL, C.E., Chairman. GEORGE RAIT, Managing Director.

HENRY HOWARD & CO.,

COOMBS WOOD PATENT TUBE-WORKS,

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PATENT WELDED WROUGHT-IRON TUBES & FITTINGS,

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JOHN HALL & CO.,

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MANUFACTURERS of FIRE-BRICKS, LUMPS, & TILES,

AND EVERY DESCRIPTION OF FIRE-CLAY GOODS.

N.B.—A Stock of 15 and 16 in. CIRCULAR RETORTS always on hand. Other kinds made to order on short notice.

SILVER MEDAL, PARIS EXHIBITION, 1867.

LLOYD AND LLOYD,

ALBION TUBE-WORKS, BIRMINGHAM,

MANUFACTURERS OF

WROUGHT-IRON TUBES AND FITTINGS

For Gas, Steam, Water, &c.

SOLE LICENSEES for the United Kingdom for the LAVENANT PATENT ENAMELLED TUBES & FITTINGS,

the Coating of which does not shell off, is a certain preservative from rust, and resists all effects of expansion and contraction.

LAP-WELDED IRON & HOMOGENEOUS METAL TUBES

For Locomotive, Marine, and Stationary Boilers.

Boiler-Tube Ferrules, Gun-Metal Gland Cocks, Water-Gauges, Whistles, &c.; Stocks, Taps, and Dies for Screwing, and Gas-Fitters Tools of all kinds.

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MANCHESTER: Barlow's Croft, Chapel Street, Salford. PARIS and LILLE.

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PATENTS FOR CHARGING AND DRAWING GAS-RETORTS,

WITH CHAMBERS FOR MOUTHS,

REQUIRING NO LUTING.

Gas Engineers are solicited to examine into the merits of this invention before erecting new or altering old retort-houses. It may be seen in action at the Alliance Gas Company's Works, Dublin, where its utility and economy will be clearly demonstrated. Although the saving in labour will be considerable, and quickly return any outlay of capital, there are other and important features strongly recommending its adoption at all gas-works, and which a gas engineer upon examination will at once appreciate.

The Directors of the Alliance Gas Company have kindly consented to give every facility to gentlemen desirous of seeing the invention in operation. Parties, therefore, about to visit Dublin will be so good as to send us their card, and we will furnish them with letters of introduction.

Drawings, &c., may be seen at our Office, and all details explained.

JOHN CHISHOLM, SON, & CO., 44, MARK LANE, E.C.

1862.

PATENT ANTIMONY PAINT.

MADE ONLY BY

GEORGE HALLETT & CO.,

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CLASS II.

This Paint having been in general use over seven years (especially in some of the principal Gas-Works), and proved itself the best light-coloured Paint produced for resisting the influence of vitiated atmospheres, it is important that its qualities should be more widely known.

It is not discoloured like white lead in a sulphuretted atmosphere, nor washed off like white zinc; and its light colour reflecting heat, produces much less expansion of gas in holders painted with it than with dark colours, besides rendering them much more sightly. Its specific gravity is so much below white lead that the same weight will cover one-third more surface, while it is equal in body; and its price being about the same (30s. per cwt.), it is actually one-third cheaper. From experience, its manufacture is greatly improved, and it is quite suitable for all purposes in which white lead is employed.

Reference is kindly permitted by the Engineers of the City of London, Commercial, London, and Surrey Consumers Gas Companies, who pronounce it the best Paint known for their purposes.

N.B.—Antimony Paint, COVERING SO MUCH MORE WORK, costs about 20s. per cwt., as compared with White Lead at 30s. per cwt.; a similar economy arises from its use in Steam and Gas Joints, for which purpose it is superior to White Lead.

JOHN WRIGHT & COMPANY,

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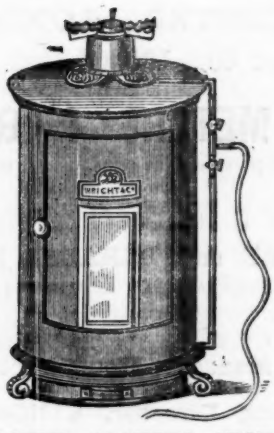
JOHN WRIGHT & COMPANY'S

IMPROVED

GAS COOKING STOVES.



SQUARE COOKING STOVE, No. 65,

With Cast-iron Top and Bottom, Door, and Frame.

14 in. square, with Small Boiling Stove on top	£3 10 0
16 in. square, with one Large Boiling and Broiling Stove on top	4 5 0
18 in. square, with two Small Boiling Stoves and one Large Boiling and Broiling Stove on top (as drawing)	5 5 0

ROUND COOKING STOVE,

No. 68,

With Cast-iron Top and Bottom, and Glass Door.

11 inch diameter	£1 15 0
14 inch diameter	2 2 0
16 inch diameter	2 12 6
18 inch diameter	3 3 0

All the Boiling and Broiling Stoves are Atmospheric.

For Roasting, Broiling, Frying, Baking, Boiling, Stewing, or Preserving, either together or separately.

The advantages of Gas Cooking are—

Its portability and cleanliness—perfect and immediate control over the heat—it requires but little attention—there is no roasting or baking fire to make up—it is always ready—it keeps the kitchen and house cool—it is economical, even where gas is dear, as it is only alight while actually in use.

WRIGHT'S

IMPROVED OPAL REFLECTOR.

7 inch White Opal	6s. 6d.
8½ inch „ „	8 6
10½ inch „ „	15 0
7 inch Green Opal	8 0
8½ inch „ „	10 6
10½ inch „ „	18 0

Shadowless Argand Burner for ditto, 2s. each.

WRIGHT'S

IMPROVED OPAL REFLECTOR,

WITH SMOKE CONSUMER.

Price 6s. 6d. each. Basins extra.

LACQUERED

AND

BRONZED.

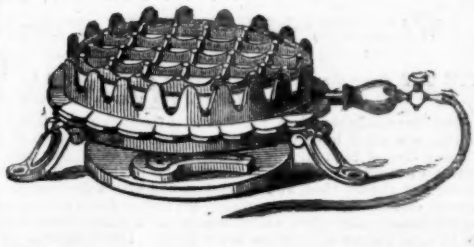
3⅝ inch	1s. 4d. each.
4⅛ inch	1s. 6d. each.
4¾ inch	1s. 9d. each.

If with Enamelled Top, White or Florentine, 6d. each extra.

WRIGHT'S

IMPROVED

BOILING AND BROILING STOVE.



This is a very powerful Stove, with Atmospheric Burner; will broil under and boil above at the same time.

Price 15s.

32½ per cent. Discount to the Trade.

GEORGE NEWTON,

(Late Senior Partner of the Globe Meter-Works,)

UNION STREET WEST, OLDHAM,

MANUFACTURER OF

IMPROVED WET & DRY CONSUMERS GAS-METERS,

GAS STATION-METERS,

With all the Joints planed,

GOVERNORS, GAUGES, INDICATORS, EXHAUST GOVERNORS, &c.

TERMS, &c., ON APPLICATION.

THE GAS-METER COMPANY

(LIMITED), LONDON,

(Successors to CROLL, RAIT, and CO., LONDON, and WEST and GREGSON, OLDHAM.)

MANUFACTURE

STATION-METERS & GOVERNORS

At their Oldham Establishment, which has long possessed the reputation of supplying this description of apparatus of the most perfect construction and appropriate design.

CONSUMERS GAS-METERS IN CAST-IRON & TINNED SHEET-IRON CASES.

STREET GOVERNORS, PRESSURE and EXHAUST REGISTERS, TEST GASHOLDERS,

AND EXPERIMENTAL GAS APPARATUS GENERALLY.

For information, &c., apply to

W. ARCHER, Manager, Meter Factory, OLDHAM;

OR TO

GEORGE RAIT, Managing Director, KINGSLAND ROAD, LONDON.

GAS AND WATER PIPES.

CLARIDGE, NORTH, & CO.,

BILSTON.

M'KENZIE'S PATENT GAS COAL.

This Patent Gas Coal is a compound of Pulverized Coal and Shale Oil. It is now used most successfully by some of the London Gas Companies, and also in Dublin and other places, for increasing the illuminating power of the Gas, which it does at less cost than Cannel Coal. The illuminating power of this Patent Coal can be made of any strength required up to 35 candles, and is in all cases guaranteed. The Coke is of the best quality, as the best Newcastle and Sunderland Coals only are used in the manufacture.

This Patent Coal is shipped at Sunderland, where works for its manufacture have been erected.

Further particulars can be obtained from

W. W. JOBSON, 16, Fish Street Hill, LONDON; or

WALKER, BRUCE, & CO., Patent Gas-Coal Works, South Docks, SUNDERLAND.

EXTRACT *from the Inaugural Address of* THOMAS G. BARLOW, Esq., C.E., *President of the British Association of Gas Managers, at their Fifth Annual General Meeting, held in London on the 2nd of June,* 1868.

Gentlemen,—In considering the progress that has been made in the manufacture and distribution of Gas during the past year, the new inventions and new processes which have been adopted or tried with prospect of success, deserve to be specially noticed. Foremost among them is M'Kenzie's process for producing Gas of high illuminating power from small Coal, mixed with crude Shale Oil. The pressure which the Legislature has recently put on Gas Companies to raise the standard of illuminating power considerably above that obtainable from common Coal, has compelled most of them to use a certain proportion of Cannel Coal, at a heavy loss, and with a diminution in the value of the Coke. The advance in the price of Cannel Coal, consequent on the increased consumption, has stimulated inquiry to find a substitute for it; and this seems to have been accomplished by Mr. M'Kenzie, whose process has been successfully adopted on a large scale at the Alliance Gas-Works in Dublin. The small Coal is well mixed with the Oil, in the proportions varying from 10 to 30 gallons of Oil to one ton of Coals. This is effected by means of a mixing or grinding mill. The Compound material is then distilled in ordinary Gas Retorts of clay or iron, at a strong heat. I have recently witnessed an experiment on a mixture of Llantwit Small Coal shipped at Cardiff, and costing in Dublin 12s. 6d. per ton, with 5 per cent. of Broxburne Shale Oil, costing £5 10s. per ton, the produce of the distillation of one ton of which mixture was—

9750 cubic feet of Gas, 21·5 Candles illuminating power.
37 bushels of good hard, saleable Coke.
2 bushels of Breeze.
11 gallons of Tar.
15 gallons of Ammoniacal Liquor, of 5° Twaddle.

The cost of this mixture, including Royalty, was about 17s. per ton, against 24s. for Wigan Cannel, over which it has the advantage of at least 5s. per ton in the value of the Coke.

FOR SALE,

SEVERAL SECOND-HAND STATION-METERS & GOVERNORS,

All in excellent Working Order, equal to New, guaranteed.

APPLY FOR FURTHER PARTICULARS TO

GEORGE RAIT, Managing Director, GAS-METER COMPANY,
238, KINGSLAND ROAD, LONDON, N.E.;
OR TO
WILLIAM ARCHER, THE OLDHAM METER MANUFACTORY, OLDHAM.

PIGGOTT'S IMPROVED RETORT-LIDS.

Convex *Rabbeted* *Dished*

The Manufacturers desire respectfully to call the attention of Gas Companies and Engineers to their Improved Retort and other Stamped Wrought-Iron Lids, which possess the following advantages over Wrought Lids hitherto manufactured:—Uniform size and shape, a smooth and even surface, and a superiority of finish hitherto unattained. These desirable qualifications are preserved *irrespective of form*.

The Manufacturers have recently laid down extensive Hydraulic Machinery, with a view to acquire the above result, and the success they have achieved in this branch of their business has surpassed their most sanguine expectations. The simple fact that these Lids fit into one die, and are stamped and cut out at one blow, is a sufficient proof that they must be necessarily alike in all respects, and superior to any other make.

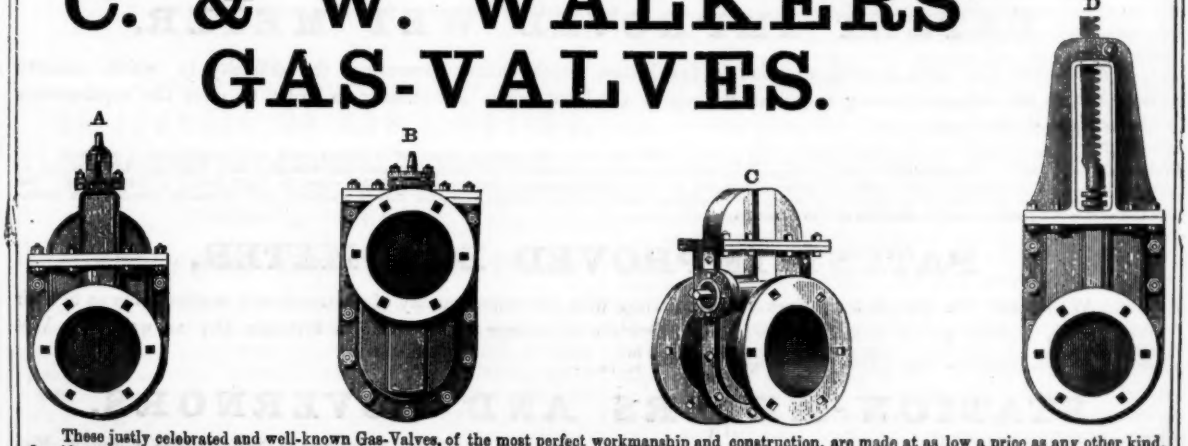
The following Gas Companies have the Lids in use, and can certify to their merits:—

Belfast,	Burslem & Tunstall,	Fazeley,	Luton,	Stoke Fenton and Longton,
Beverley,	Bury,	Gloucester,	Nottingham,	South Shields,
Birkenhead,	Carlisle,	Harrogate,	Nuneaton,	Southampton,
Birmingham and Staffordshire,	City of London,	Huyton and Roby,	Perth,	Stockton,
Bombay,	Cowes,	Leeds,	Preston,	Tunbridge Wells,
Bradford,	Croydon,	Leicester,	Portsea Island,	Victoria Docks,
Brighton,	Crystal Palace,	Liverpool,	Rossendale,	Warrington,
Brighton and Hove,	Derby,	Longport,	South Metropolitan,	&c., &c.
	Equitable, London,	Lowestoft,	London,	

PRICE LISTS ON APPLICATION.

THOMAS PIGGOTT & SON,
ENGINEERS, CONTRACTORS, and IRONFOUNDERS,
GASHOLDER, GAS APPARATUS, & STEAM-ENGINE BOILER MAKERS,
SWALLOW FOUNDRY, SPRING HILL, BIRMINGHAM.

C. & W. WALKERS' GAS-VALVES.



These justly celebrated and well-known Gas-Valves, of the most perfect workmanship and construction, are made at as low a price as any other kind. A—Above-ground Screw Gas-Valve, with improved indicator to show when open and shut, is the best Valve for Purifiers where the most perfect tightness is required, and for heavy pressure generally. B—Under-ground Screw Gas-Valve. C—Internal Rack Gas-Valve, with pinions of homogeneous metal. D—Ordinary Rack and Pinion Valve, with strong undamageable racks and pinions.

MIDLAND IRON-WORKS, DONNINGTON, NEAR NEWPORT, SHROPSHIRE,
AND 8, FINSBURY CIRCUS, LONDON, E.C.

THE

UNIVERSAL EXHIBITION OF PARIS,

1867.

SILVER MEDAL.

THOMAS CLOVER & CO.,

DRY GAS-METER MANUFACTURERS,

214 TO 222, ST. JOHN STREET, CLERKENWELL GREEN,

LONDON,

HAVE BEEN AWARDED THE HIGHEST PRIZE FOR

DRY GAS-METERS,

BY THE IMPERIAL COMMISSIONERS FOR THE

UNIVERSAL EXHIBITION, 1867.

WILLIAM PARKINSON AND CO.

(SUCCESSORS TO SAMUEL CROSLEY),

PATENT WET AND DRY GAS-METER MANUFACTURERS, &c.

COTTAGE LANE, CITY ROAD, LONDON, E.C.

Established 1816.

PATENT IMPROVED WET METER.

W. P. and Co. invite especial attention to this Meter, which entirely overcomes the difficulty to which ordinary Wet Meters are subjected, owing to the short range of the Float, which is necessary, in order to meet the requirements of the Sale of Gas Act.

"It is well known that n Meters constructed so that the valve will close when the water is drawn off to such a point as to render them 3 per cent. slow the lights are liable to be extinguished by the closing of the valve by a sudden increase of pressure. To meet this difficulty, Mr. Pinchbeck has invented an ingenious and simple arrangement by which the action is reversed, and any such increase of pressure, in his Meter, raises the value instead of depressing it. The fact of the improvement having been adopted by Messrs. W. Parkinson and Co. is a sufficient guarantee that it practically and effectually remedies the inconvenience it is designed to meet."—JOURNAL OF GAS LIGHTING.

PATENT IMPROVED DRY METER,

Which W. P. and Co. pledge themselves to manufacture with the same quality of materials and workmanship as in their Wet Meter, thereby giving Gas Companies and others the advantage of procuring a first-rate Dry as well as a Wet Meter, which, hitherto, they have been unable to do.

STATION-METERS AND GOVERNORS.

Which can be seen at all the London Gas-Works. Also Liverpool, Manchester, Sheffield, Nottingham, Belfast, Glasgow, Birmingham, Dublin, Bristol, Leeds, Leicester, Brighton, Southampton, Sunderland, Wolverhampton, Bradford, Norwich, &c., &c.

TEST GASHOLDERS, EXPERIMENTAL METERS, EXHAUSTER REGULATORS,

MINUTE CLOCKS, PRESSURE GAUGES, PHOTOMETERS, PRESSURE REGISTERS, &c.

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TO CORRESPONDENTS.

No notice can be taken of anonymous communications. Whatever is intended for insertion, must be authenticated by the name and address of the writer; not necessarily for publication, but as a guarantee of good faith.

NOTICES.

The subscription to the JOURNAL is 15s. per annum, if paid in advance during the month of January, or 18s. credit, in two sums of 9s. each, in July and January of each year. Post-Office orders should be made payable at the Money-Order Office, London, to William B. King, 11, Bolt Court, Fleet Street, by whom the business department of the JOURNAL is conducted.

Stamped copies, when forwarded by post, must be folded so as to expose the stamp; they are otherwise liable to the full postage charge for letters.

The next number will be published on Tuesday, August 17, and the subsequent numbers on each successive alternate Tuesday.

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All communications for the Editor to be addressed, "No. 42, Parliament Street, Westminster;" and all remittances for subscriptions or orders for advertisements to the Publisher, No. 11, Bolt Court, Fleet Street.

THE JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

TUESDAY, AUGUST 3, 1869.

Notes upon Passing Events.

THE Royal Agricultural Society has been holding its thirtieth annual show, at Manchester. The first was held at Oxford, in 1839, when many demi-gods of agriculture and science, since dead, assisted. Perhaps Oxford was one of the greatest gatherings of agricultural and political notabilities that ever took place in this or any other country. At a time when politics ran very high at Oxford, neutral ground was found. The leaders of the movement were full of enthusiasm. They dreamed of much from science—Dean Buckland and Dr. Daubeny assisted; they dreamed much of regenerating the live stock of Great Britain, and their dreams on both questions have not been altogether unrealized; but they never dreamed that in future shows the engineer-mechanic would occupy the most important place. At Oxford, three or four waggon-loads, chiefly contributed by the first firm that brought mechanical science to bear upon agricultural tools, represented the total display of implements and machinery. For their collection, the Ipswich firm received a well-deserved gold medal. At Manchester, out of five miles of avenues of covered sheds, more than half were occupied by the manufacturers and vendors of the manufactured goods that agriculturists require. The enthusiasm of the noble and gentle amateurs has disappeared with them, and with the substitution of real business for a museum-like exhibition. All honour to the men of the past! They, actuated by patriotism or love of science, laboured zealously, without the least idea that, at a future day, the work would be taken out of their hands, and done much more efficiently by their pupils—men who worked only for profit. The survivors of the original council could not, at first, accept the inevitable results of their theoretical labours. They were vexed to see a scientific show turned into a mere fair where goods were brought much more for sale than to win prizes, and where prizes were only another form of advertising; forgetting that the great object of the society was to put the best tools and the best machinery in the hands of the farmers. But times have changed, and landlords and farmers, and councillors and presidents of the Royal Agricultural Society, have changed with the times, and the logical facts, no longer to be denied, decide that it is as the holders of a mart, a bazaar, or a fair, like those of mediæval times, that the Royal Agricultural Society owes its greatest claims to public support.

Thirty years ago chemistry applied to agriculture was only known to the attendants of Sir Humphry Davy's lectures at the Royal Institution: now every farmer who pretends to make a profit out of capital invested, buys his artificial manures and his feeding-stuff on the strength of a chemical analysis. Thirty years ago artificial manures were unknown; twenty years ago they were the safe subjects of after-dinner jokes by stupid squires and county M.P.'s. Now guano, superphosphates, nitrate of soda, and their compounds, are as certain to be used on every farm that grows roots as the time-honoured and indispensable muck. Indeed, farmers who resist as much as possible the use of machine-saving labour will be found liberal in their application of portable manures to their root crops. All the regions of the earth have been ransacked for the materials of superphosphates, and all the rainless regions for guano. The seed trade, which thirty years ago scarcely existed, and was only carried on in little shops, has become a calling in which large capitals are invested, and all the resources of science employed. Thirty years ago, with the exception of Scotland, where millwrights had early produced threshing-machines of a rude character, and one county of England, where a manufactory had been established to supply ploughshares and drills to the three counties that had the sense to use them, the rest of agricultural England was chiefly dependent on the nearest blacksmith's shop for all tools and implements. Machinery was almost unknown. Twenty years ago an active member of the council of the Royal Agricultural Society boasted that all his farm implements were made on his farm, or supplied in his parish. At Manchester, the customers of the manufacturers who have sprung up in every district of England to supply the mechanical wants of agriculturists were not great landlords or wealthy tradesmen, amusing themselves on fancy farms, but rent-paying farmers, who have discovered that their only safety lies in *labour*-saving and, still more important, *time*-saving implements. The Royal Agricultural Society, which in its first prospectus scarcely alluded to the improvement of agricultural implements, commenced its first serious operations by offering prizes for machines for making draining tiles. The operation of draining with tiles on a system was by no means generally accepted twenty years ago: now no farmer of capital will have anything to do with an undrained farm, and drain-tile making machines are as familiar as mangles. Ploughs, harrows, and all cultivating implements are manufactured by machinery with the best tools, and turned out by the gross. The system of broadcasting wheat has almost disappeared within twenty years; the use of a drill for sowing is everywhere a matter of course for root crops and wheat crops; the horse hoe has accompanied and come into use with the root drill. The natural consequence of the demand for these machines has been the employment of skilled mechanics of a very high character in their manufacture.

The Great International Exhibition of 1851 introduced us to reaping-machines; these were followed by mowing-machines, which have come into general use, and created a regular trade with great competition between rival patentees. Their adoption has been accompanied by that of horse rakes and hay-making machines. In the class of implements for saving crops, ingenuity is now actively directed to producing mechanical means for transferring hay or corn-sheaves from the cart to the stack, and superseding the labourer's "pitching-"fork." American ingenuity has made considerable progress in this direction, and at Manchester several contrivances received the approval of practical farmers. Within less than twenty years steam-driven threshing machinery has superseded the flail as much as the drill has superseded the broad-casting sower with his sheet. In all these contrivances for cultivating the land and gathering crops the ideas are old; the change has been in the substitution of iron and steel for wood, the perfecting of mechanical arrangements, and the cheapening in price consequent on popular adoption. Horses supersede men, and steam supersedes horses. It is not necessary any longer to discuss at farmers clubs and in agricultural works the value and superiority of iron-wheeled ploughs, of iron rollers, of horse drills, horse hoes, and steel-pointed cultivators; of steam-driven threshing-machines, and horse-driven reapers or mowers. These are settled questions; but at Manchester it was made evident that steam cultivation had long passed out of the stage of experiment. Steam cultivation is as much an established fact as steam threshing. Steam will cultivate land more quickly, more deeply, and consequently more profitably than any number of horses can. Steam can make profitable those stiff clays which, in wet seasons, are the despair of old farmers, and yet are the most fertile with the least manure if they can be properly aërated. In a word, the Manchester Agricultural Show made it plain that the future produce and profits of agriculture in this country are chiefly dependent on mechanical ingenuity, combined, as it is now combined, with agricultural experience and large capital.

Students of our agricultural history cannot fail to be struck with the long period in which the germ of valuable improvements lay undeveloped. The ideas of all the most valuable agricultural implements are very old. Thirty, forty, fifty, and a hundred years before they assumed a practical shape, ingenious men conceived plans for economizing labour; but, first, labour was so redundant that such schemes were received with little favour by either landowners or tenants heavily taxed to support paupers, for whom there was no reproductive work. Secondly, the general introduction of capital into farming is quite a modern change. Thirdly, agriculture, which only yields crops once a year, and therefore only allows the farmer to turn his capital once, does not present the temptations to enterprise offered by manufactures. Lastly, until steam-driven factories and railways had created an army of skilled mechanics, and carried coal into inland coalless districts, mechanical projectors could with difficulty find any one able to execute their ideas. The village blacksmith, much improved in position, now confines his work of the farm to the repair of machines and tools turned out of factories, where all the appliances of Lancashire machine-makers are employed, and manual labour is used as little as possible in the rough stages of production. One of these great agricultural machine factories, situated on a navigable river, with railway sidings in its yard, employs 600 men, as much more steam horse power, and carries to the utmost the division of skilled labour. Peasant cultivators have their place in European cultivation, but if the agricultural world could be cut up into fifty-acre lots machinery would disappear, which could never have been invented under peasant cultivation, to the enormous loss of produce.

The session, now rapidly drawing to a close, cannot be called barren which has completed a Bankruptcy Bill on rational principles; an Endowed Schools Bill, which will galvanize hundreds of thousands of pound sof comatose charities; and, finally, has doubled the telegraphic facilities of the kingdom by the Telegraphs Purchase Bill. The Government is so strong that it can do pretty nearly what it pleases with details when once the House of Commons has affirmed a principle. That the Government should have a monopoly, if telegraph facilities were to be extended to unprofitable districts, and if the price of messages was to be reduced to a low uniform rate, was essential. If monopoly had not been conceded, some companies would have started up for working the main trunk lines between the manufacturing centres and ports of the kingdom; but the small minority had all the best of the argument when they proposed to limit the monopoly to seven years. In seven years the whole question might be properly reviewed without the necessity of a formal attack on the Government in the shape of a motion for inquiry. As regards improvements in telegraphic apparatus, we suspect that we shall be greatly dependent on American experience. Nothing is so slow to improve, or so apt to adopt the wrong thing, as a Government department, when once the officers have ceased to be "new brooms." The Post-Office, abominably managed, is an example. In the navy, wherever necessary to turn salt water into fresh, Dr. Normandy's apparatus is now universally employed; but after this apparatus had been successfully adopted by the Peninsular and Oriental, Royal Mail, and other commercial steamboat companies, we have reason to know that its use by the navy was long successfully resisted, because an official had patented and introduced his absurdly inferior process of distillation—a process which was not cheap, and whose products were nasty.

We are glad to observe that Mr. Cardwell and other members of the Government have openly declared against Government officials being also patentees. Such men, however ingenious, are the most formidable obstructors of improvement. Inventors soon learn that their plans are received, examined, rejected, or adjourned, and after a decent time reproduced in whole or in part by the official patentee. The history of every manufacturing department of the Government presents many cruel examples of this abominable kind of piracy. But times—that is, political times—are changing in a very remarkable manner. In the House of Commons, on Monday, Mr. Frederick Winn Knight, one of the stiffest of old Tories, but also one of the most intelligent amateur soldiers of the day—he fought as a volunteer against Russia in the East thirty years ago, before he became a major of yeomanry and a colonel of volunteers—battered the War Office for their slowness in not adopting a camp equipage which would keep the soldiers in campaigns off the ground, and which has received the hearty approval of many distinguished officers, including Lord Napier of Magdala. Mr. Knight was warmly supported by two modern Conservative soldiers, Colonel Annesley and General Herbert, who both alluded to the difficulty of inducing the official mind to accept any improvement. In the good old days of the Duke of York, Commander-in-Chief, these reforming soldiers would each have had a black mark against his name in the Horse Guards books. On the merits of Major Maguire's camping system we do not profess to have an opinion, but it is something new and hopeful to see such subjects so treated by county members and aristocratic soldiers. It seems only the other day that Colonel Cotton, in a rambling book full of valuable facts, and in papers at that pleasant refuge for the destitute with ideas, the Society of Arts, was trying to impress on the country the necessity of developing India by reproductive works. His ideas have been silently making way ever since the mutiny, and this session the Duke of Argyll, following out the principles adopted by the Marquis of Salisbury, has sketched a plan for investing twenty or thirty millions of public money in the direct construction of Indian railways and irrigation works. The guarantee system, having done its work, and had its day—having been as useful, is now as much out of date, as a four-horse coach—will have formed the materials in men for Government enterprise. The writer of the City article of the *Times* safely prophesies that between the demand for telegraph stock, in whatever shape issued, and the loans which must be raised by the Indian Government to complete their railway system, the day of cheap money will shortly disappear, not to return very soon.

The Admiralty administration is also undergoing a complete transformation under the direction of men of business. Mr. Seely's aggravating labours have "struck ile" for Mr. Childers and Mr. Baxter. The system of purchasing materials by tenders, or samples and patterns, has been overhauled, and found to be—to put it mildly—a costly mistake. Mr. Baxter has decided to purchase what the Government requires on the same terms and in the same manner that a great firm would that could pay cash. Of course there is a terrible outcry from the Tite barracks, but the balance-sheet will settle the question. All great manufacturing and trading firms rely, for the selection of the goods they require, on competent persons, whom they select carefully, pay handsomely, and dismiss if found dishonest or incompetent. On the same

principles, millions may be saved by the Government. But what could be expected when important purchases were made by contracts which were usually founded on "knock-outs," under the direction of gentlemen who had attained their official position by punctual attendance, neat handwriting, and exactness in correspondence during a series of years, without the slightest knowledge of timber, iron, coals, or canvas. Mr. Baxter's system will want looking after, but the Admiralty vote will be a sure thermometer for the financial reformers of the future. We trust the same principles will eventually penetrate the Public Buildings and Woods and Forests departments.

THE PETROLEUM BILL.

Among the first batch of "innocents" sacrificed by the Government was the amended Bill for the safe-keeping of petroleum. The temporary loss of this measure is not to be regretted. The main purpose of the Bill—the relief of retail dealers in "benzine-collas" and similar oils—will be effected when it is understood that the authorities have no wish to interfere with a trade carried on with due regard to public safety. In other respects the Bill was little more than a re-enactment of the Acts of 1862 and 1868. The only clause likely to excite discussion was that one which retained the temperature of 100° Fahr. as the limit of danger. It was understood in the House of Commons that this limit would be opposed in the interest of British manufacturers, who are naturally anxious to have a higher temperature fixed upon. Most of the British oils used for illuminating purposes will stand a heat of 120° Fahr., or even more, without giving off inflammable vapour, and the manufacturers are somewhat at a disadvantage in competing with the lighter American article in our own market. The limit to 100° Fahr. must be regarded as a concession to the merchants who deal in foreign petroleums, who argue that, without some general agreement with foreign states, it would be detrimental to our trade to fix upon an exceptionally high standard. It may be so, but it would be perfectly easy, in any future Bill, to deal separately with the home retail trade; and we are satisfied that it would contribute greatly to the safety of the public, if an absolute prohibition were placed upon the sale by retail of all oils used for illuminating purposes which give off an inflammable vapour at less than 120° Fahr.

The schedule to the Bill prescribed a slight alteration in the form of the apparatus to be used in applying the "flashing "test," and also directed the very gradual heating of the water-bath. On this point we may remark that there is a twofold liability to error. If the water is heated rapidly, the flashing point may be made much too high; if it is heated very slowly, the flash may be obtained at a very low temperature. To obviate this double liability to error, the Bill directed the heat to be applied so that the temperature of the water might be raised about one degree per minute—an instruction it will be well for all examiners to act upon.

The Bill included nitro-glycerine among the inflammable oils requiring a licence for storeage, and a particular label; but, as regards this article, another Bill has been introduced into the House of Commons, which absolutely prohibits its importation for one year, and puts such restrictions upon the sale and transport, if made in this country, as will practically suppress the manufacture. If this Bill should pass, the use of nitro-glycerine must be abandoned, or it must be made on the spot and at the time it is required. This is the plan adopted in some French quarries. Nitro-glycerine is made by a very simple process, which can be conducted by any intelligent labourer. The Bill, which has passed the House of Commons, allows the transport of such an article as dynamite, if a Secretary of State can be persuaded that it may be carried with safety.

SEWAGE.

An inspection of the sewage works at Leamington on the invitation of the Native Guano Company, and a visit to the sewage farm at Warwick close by, gave us the opportunity of seeing in progress two rival schemes for the utilization of sewage. The question, "How to dispose of sewage?" becomes more and more urgent every day. Everywhere almost excluded from rivers, shut out in places from the sea, prevented sometimes from irrigating, engineers are often at their wits end to know what to do with sewage. A thoroughly good plan for its precipitation and purification would solve the difficulty. It would, as we have said before, be worth more than a gold-mine to the discoverers, and would produce enormous benefits all over the country. But no such plan seems possible in the present state of chemical science. When we say that we cannot accept the "A. B. C." process we saw in operation at Leamington as a satisfactory solution of the difficulty, we must not be supposed to express an unmitigated condemnation of the scheme. As our readers know, the process takes its name from the initials of the materials employed in the purification—animal charcoal, blood, and clay. Alum is also used, and other materials—gypsum and magnesian salts, we believe; and, finally, the effluent water is deodorized by means of perchloride of iron. There is, it will be seen, only one novel ingredient employed—namely, blood—the advantage of which may be considered doubtful. The way in which this mixture is employed, and the deposit is collected, can be easily imagined. The sewage flows first into a mixing-tank, where it is strongly agitated with the compound, and then it passes on into one of a series of depositing-tanks, where most of the precipitate quickly subsides. The supernatant liquid then runs away over dams to a serpentine canal, with a gentle fall about a hundred yards long, passing in its course through a couple of screens; and then, after traversing a filter of sand and charcoal, runs away into the River Leam. It must be admitted that sewage so treated ought, at all events, to be perfectly free from suspended impurity; but, owing to some disarrangement of the filter, this was not the case at the time of our visit. The effluent water was, however, quite free from offensive odour. The thick sludge left in the depositing-tanks is afterwards pumped up into centrifugal machines, and dried, as far as possible, by those means; and the now tolerably consistent material is spread in the air to complete the desiccation. It is subsequently collected in heaps, in which decomposition of the organic matters, attended with a considerable development of heat and some evolution of ammonia takes place, and the heaps are sprinkled with dilute sulphuric acid to fix the ammonia evolved. Such is the process. It will be seen to closely resemble that of Messrs. Stothert and Gotto, about which much was said some twelve years ago. Of the practical value of the plan for the purification of sewage, we are hardly in a position to judge in the absence of satisfactory analyses of the sewage treated, and of the effluent water. Of the commercial value we shall only be able to form an opinion when we know the cost of the materials put in, and the worth of the manure obtained. On these points we are promised some enlightenment; but we were informed that the manure commands an increasing sale at a good profit.

Whether the process is likely to be continued at Leamington looks doubtful, since we see that the Earl of Warwick is in treaty with the Local Board for a concession of the sewage for thirty years. The Earl offers £450 a year for the sewage of a population of 25,000, delivered on the ground he requires it. The sum offered looks very small to members of the Board, who are not convinced "that the commercial value of sewage "has yet to be ascertained." A visit to the sewage farm at Warwick, however, might satisfy any one that irrigation may be employed for some time to very little purpose. The farm covers about 100 acres, consisting for the most part of the stiffest clay soil. The ground slopes irregularly, but it has been skilfully laid out by Mr. Clifford, the manager, who has had much experience with irrigation works in India. The whole acreage has been sown with Italian rye grass, and up to the present time the result has not been encouraging. The nature of the soil is certainly against the experiment. While under sewage it is converted into thick tenacious mud; and when the liquid is shut off, it becomes in a few dry days so hard as almost to defy the plough. Besides this, the sewage applied must be very poor, for water from land springs in great abundance finds its way into the sewers near the pumping-station. A few of the fields are now yielding a good return, and we saw some fair crops standing. The cut grass at this time of the year meets with a ready sale, but the demand is unequal. On the whole, the experiment at Warwick cannot at present be regarded as either a failure or a success. The Board have already spent about £1200 in laying out the farm, but much more will have to be expended before it is made reasonably productive.

Among the numerous places in doubt and difficulties as to what to do with their sewage, we may still mention Walton and West Derby. Our readers will remember the controversy

last year between Mr. Rawlinson and Messrs. Reade and Goodison. The latter gentlemen proposed to utilize the sewage of the two places jointly by irrigating a tract of sandy porous soil conveniently situated for the purpose; while Mr. Rawlinson, to every one's astonishment, decided to carry the sewage into the sea. In the end the two Boards could come to no agreement. Walton decided to irrigate; West Derby determined to waste, and required a loan of £22,000 to effect it. Before this could be obtained, Mr. Arnold Taylor was sent down to hold an inquiry, and, he having reported against the sea scheme, the Home Secretary has recommended the West Derby Board to take measures for joint action with Walton in the utilization scheme. The Rivers Pollution Commission, too, have advised that no more sewage should be allowed to be discharged on the neighbouring shore of the Mersey. Mr. J. C. Morton had before that written a strong report in favour of the West Derby and Walton utilization scheme. The triumph of Messrs. Reade and Goodison, therefore, seems complete, and the scheme they originally submitted to the two Boards will be carried out.

The inquiry by Mr. Rawlinson into the alleged pollution of the Thames at the outfall of the northern sewers is still going on. In the early stage of the inquiry Mr. Hawkshaw gave evidence for the Barking memorialists, to show that, since the establishment of the outfall works, considerable alterations had taken place in the river, and that large deposits of sewage mud had accumulated. On Monday week Messrs. Bidder, Gregory, Hawksley, Hemans, and Haywood were examined, who all agreed that the river has not been at all injured by the outfall works. Drs. Miller and Odling were also called to prove that the deposit at the mouth of Barking Creek is ordinary river mud, and not deposit from sewage. On Saturday some coastguardsmen, who had been stationed at the mouth of the creek, and some Barking lightermen were called to prove that the navigation of the creek had not been interfered with. Some admitted a considerable deposition of mud at one part, but ascribed it to the coffer-dams of the Reclamation Company. The inquiry will be continued on Saturday.

This inquiry would seem to be prompted, if not promoted, by the Essex Reclamation Company. Notwithstanding the vaunted success of the Lodge Irrigation Farm, at Barking, the company does not seem to have gone on with the works necessary for the conveyance of the sewage to the Maplin Sands, and the time allowed for their completion will soon expire. It is alleged that the prospects of the company have been seriously injured by the statement in the last report of the Board of Works, "that the value of sewage, in a commercial point of view, is a question which still remains to be solved." Under these circumstances, perhaps, the affairs of the company might be improved if the Board of Works could be compelled to take the sewage out to sea, and so *prevent* the company from completing their bargain. In such a case, possibly, a claim for compensation might arise against the Board of Works. In the course of the inquiry, Mr. Rawlinson dropped a remark which we may commend to the notice of the Boards at Leamington, Warwick, and West Derby. He said that, from "investigation and inquiry, he had long since ceased to regard it as positively necessary for the utilization of sewage that it should pay under all or *any* conditions." This is poor comfort for the ratepayer, who has been so often told that the gas and sewage which run side by side under our streets are of equal value, though the one yields a large profit and the other runs to waste.

Circular to Gas Companies.

The passing of the Imperial Gas Company's Bill, in defiance of the recommendations of the report of Mr. Cardwell's committee, has excited the indignation of those who desired to trammel the gas legislation of the metropolis with such conditions, and to make all the London gas companies conform to the provisions of the City of London Gas Act of last session. Mr. Goldney, a member of Mr. Cardwell's committee, gave notice, in the House of Commons, of his intention to move in the matter, and "to call the attention of the House to the present unsatisfactory state of gas legislation for the metropolis, and to ask the President of the Board of Trade if the Government will introduce a Bill, in the next session of Parliament, for securing uniformity in the illuminating power and price of gas, or, failing that, to enable the public generally to free themselves from district monopoly, and to obtain their supply of gas (subject to certain defined regulations) from those companies who are willing to supply it, and have engaged by Act of Parliament to supply it, at increased illuminating power and reduced price." The President of the Board of Trade is too shrewd a man not to perceive the folly of attempting to force rigorously the same price and illuminating power on all the metropolitan gas companies alike, who, though occupying adjoining districts, are in some cases as differently circumstanced as if they were in different parts of the kingdom. It would be still more palpably absurd to discard the lessons of experience, and attempt to set aside the "district monopoly," which has conferred admittedly great advantages on the consumers of gas as well as on the gas companies. Mr. Goldney himself seems, on reflection, to have become aware of the inexpediency of persisting in mooting the subject, for his motion has dropped out of the notices, and no question appears to have been asked. The *Standard* has also been calling attention to the difference in the illuminating power required by the Imperial Gas Company's Act and by the City of London Gas Act of last session, and contends that "gas ought to be as cheap and as good in one part of London "as another;" and, unless such uniformity be obtained, a new agitation is threatened "as soon as the new Acts come into "operation, which will be more vehement and active than any "which has preceded it." It is admitted, however, that "a difference may be allowed between the central parts and "the outskirts;" but, if so, where is the line of demarcation to be drawn? The *Standard*, indeed, urges that the 16 candles of illuminating power imposed on the three City companies should be levelled to the 14 candles which the Imperial and South Metropolitan companies are to supply; but it would "level up" all the other companies to the same standard, and it is suggested that they should be invited by the Metropolitan Board of Works to consent to the bringing in of a Bill to equalize the conditions of supply to those imposed on the two companies by the Acts just obtained. But it would surely be more wise in the Board to wait until the Acts of 1868 and 1869 come into operation. It may be found that even 14-candle gas, at the price of 3s. 9d. per 1000 feet, is incompatible with the maintenance of the dividend of 10 per cent., to which Mr. Cardwell's committee gave their sanction, as prescribed by Parliament, and the renewed agitation is not threatened to commence until those Acts are in full operation. The eight other metropolitan gas companies who continue under the provisions of the Act of 1860 would certainly not acquiesce in the proposed change before the practical result of recent legislation is known; and the agitators, if they be not too "vehement" to be restrained, would do well also to wait for the same result. As to the suggested interference of the Metropolitan Board in the matter, it may be asked what they or the consumers of gas have obtained for the large sums squandered in opposing the Bill of the Imperial Company. If they intend to do anything effectively, their best course would be to open amicable negotiations with the gas companies, to ascertain on what terms they are willing to sell their undertakings, as the Glasgow gas companies have done.

The referees appointed by the Board of Trade to carry into effect the provisions of the City of London Gas Act of 1868, so far as regards the illuminating power and purity of the gas supplied by the companies included under that Act, have issued a circular to the chief provincial gas companies, inviting them to reply to fifteen questions, and promising in return to communicate the result of their inquiries, but without pledging themselves that the information shall not be used to the prejudice of the parties giving it. The questions to which answers are solicited are as follows:—

1.—Description and name of coal used.
2.—Amount of gas realized from one ton of coal.
3.—Quantity of gas annually made.
4.—Greatest daily make in winter.
5.—Illuminating power of the gas produced.
6.—What apparatus is used for ascertaining the illuminating power.
7.—Description of material used for purifying the gas from sulphuretted hydrogen.
8.—Means adopted for freeing the gas from ammonia.
9.—Number of purifiers in use, with their size.
10.—Number and size of scrubbers.
11.—What liquid is used in them.
12.—What number of grains of sulphur per 100 feet is left in the gas.
13.—By what apparatus is this ascertained.
14.—What number of grains of ammonia per 100 feet is left in the gas.
15.—By what means is this ascertained.

This proceeding appears to us a very undignified one on the part of the referees. They are not commissioners appointed to collect evidence on questions upon which they are presumed

to be themselves perfectly well informed; and to find them, nine months after their appointment, embarking on a fishing excursion with the view of collecting evidence, rather indicates that they are incompetent to perform the functions assigned to them, and seek to strengthen themselves by taking counsel with the gas manufacturers of the provinces. Many of the questions are, indeed, wholly irrelevant to the objects for which the referees were appointed, and savour strongly of being asked for private purposes. What, for instance, have the referees to do with the amount of gas realized from one ton of coal in a provincial town, or the quantity of gas annually made, or the greatest daily make in winter, or the number and sizes of the purifiers in use? All these, it is true, might be very proper questions for the Chartered Gas Company to ask in view of an approaching revision of the quality and price of their gas, but are matters which do not concern the referees, and we altogether doubt the expediency, under the circumstances, of any replies being returned; but the referees should be left to act on their own judgment in the exercise of their judicial functions.

The question of purchasing the works of the Sheffield Gas Company by the Corporation was taken into consideration at the last meeting of the Town Council. The existing capital of the company amounts to about £300,000, and they are authorized by their Act, passed in 1866, to raise additional capital to the extent of £350,000. The holders of the original £100 shares receive 10 per cent. dividend, and their present value in the market is about £200. None of the new shares have yet been issued; and it was urged at the meeting that if it be desirable to purchase the undertaking, it should be done at once, before the expenditure is increased. It was contended, by those favourable to the purchase, that large sums of money are uselessly expended by the gas company, and that if the works were in the hands of the Corporation, gas might be supplied to the public at a cheaper rate than the present charge of 3s. 3d. per 1000 feet, leaving also a considerable surplus, after paying annuities adequately remunerative to the shareholders. On the other hand, the manager of the gas-works, who is one of the aldermen, adduced various statistical details respecting the supply of gas at Manchester, to show that the gas consumers of Sheffield had been supplied at lower prices than were charged in that model city of Corporation management; and he was strongly of opinion that if the Sheffield Gas-Works were purchased by the Corporation the expenditure would be increased, and that the consumers would not be so cheaply supplied as at present. After a long discussion, the nominee directors of the gas company, appointed by the Corporation, were requested to report on the probable advantages to the public of purchasing the gas-works, and the matter stands over for further consideration.

The proposition to remove the gas-works at Southport, which are in the hands of the Corporation, from the centre of the town to some more suitable locality in the neighbourhood, was fully discussed at the last meeting of the Town Council, and was rejected almost unanimously, on account of the great expense such removal would involve. The report of the Gas Committee to whom the question had been referred stated that the cost of the proposed new site at the end of three years would be £31,000 more than the cost for the same period on the present site, including the required extensions; therefore they thought it would be unwise to expend so large an amount of money for such a purpose, and urged the desirability of making arrangements in connexion with the present works, to meet the requirements of the town for at least five years to come. Only one town councillor advocated the removal of the works at the estimated cost, and the report of the Gas Committee was confirmed.

The proceedings at the last meeting of the Devonport Gas Company, reported in another column, present a remarkable instance of the errors into which some gas companies fall in the appropriation of their profits. The share capital of that company is, we believe, £52,000, which would entitle them, in accordance with a provision of the Gas-Works Clauses Act, to have a reserve-fund of £5200; but, instead of carrying the amount of their surplus profits to such a fund, they have written off £17,000 from the original cost of the works; and it is stated that during the last year only £250 has been charged to capital out of an expenditure of £1000 on new mains. The further sum of £350 of borrowed money has also been paid apparently out of profits, the excess of which, after paying dividends at the rate of 10 per cent. to the shareholders, ought to have been applied towards a reduction of the price of gas. No one need be surprised, when such mistakes as these are committed, that there is dissatisfaction in Devonport at the price of gas compared with that in the adjoining borough of Plymouth. The consumers have, indeed, the remedy in their own hands, by petitioning the Court of Quarter Sessions to appoint an accountant to examine the actual state and condition of the undertaking, and to make a reduction in the price of gas if the profits be found to have exceeded the amount required to pay the prescribed dividends and to complete the reserve-fund. Few gas consumers, however, have sufficient interest in the matter to induce them to take the trouble and incur the expense of such proceedings against a gas company. The interests of the public would be much more readily and more satisfactorily promoted by procuring the appointment of efficient independent auditors of the accounts, as provided in the recent metropolitan gas Acts.

The season is approaching when the filibustering fraternity are usually on the look-out for attacking thriving gas companies that are without statutory powers, or unprotected works belonging to private individuals, and are preparing parliamentary notices for the formation of bubble companies, to be launched when opportunity offers. There are still 700 gas-works in England and Wales that are carried on without parliamentary authority, therefore there is an ample field for the exercise of the industry of interested agitators; and it behoves the proprietors of all unprotected gas-works to be on the alert to notice any signs of approaching danger, and to guard against it by applying for parliamentary powers.

Correspondence.

THE GAS REFEREES AND MR. HEISCH.

SIR,—Surely we have had enough of Mr. Heisch. As if he had not run deep enough into trouble by his remarks on the referees ammonia test, he falls into a new error in his last letter, in which he proposes that the testing for ammonia should be made continuous for three days. If Mr. Heisch had read the Act under which he is appointed one of the gas examiners, he would have known that it is quite impossible for the referees to prescribe a test of such duration, seeing that under the Act a separate test must be made for each separate day.

68, *Bedford Gardens, Kensington,* W. H. LE FEUVRE.
July 30, 1869.

Parliamentary Intelligence.

HOUSE OF LORDS.

TUESDAY, JULY 20, 1869.

The TRURO WATER Bill was returned from the Commons, agreed to.

THURSDAY, JULY 21.

The EDINBURGH AND DISTRICT WATER, and the SLIGO BOROUGH IMPROVEMENT Bills, were returned from the Commons, with the amendments agreed to.

MONDAY, JULY 26.

The following Bills received the Royal Assent.—DORKING WATER; IMPERIAL GAS; KEIGHLEY GAS; SOUTH METROPOLITAN GAS; BRADFORD WATER; TRURO WATER; EDINBURGH AND DISTRICT WATER; and SLIGO BOROUGH IMPROVEMENT.

HOUSE OF COMMONS.

MONDAY, JULY 19, 1869.

The TRURO WATER Bill was read a third time, and passed.

TUESDAY, JULY 20.

The EDINBURGH AND DISTRICT WATER, and the SLIGO BOROUGH IMPROVEMENT Bills.—The Lords amendments were agreed to.

Legal Intelligence.

NORFOLK CIRCUIT.—CAMBRIDGE, FRIDAY, JULY 30.
(*Before the* LORD CHIEF JUSTICE *and a Special Jury.*)

BURROWS *v.* THE MARCH GAS COMPANY.

This was an action brought to recover damages caused by an explosion of gas in the plaintiff's house.

Mr. KEANE, Q.C., and Mr. MEREWETHER were for the plaintiff; Mr. O'MALLEY, Q.C., and Mr. GRAHAM for the defendants.

The plaintiff is a grocer and draper at March, and the defendants are a private company formed for the supply of gas. In May last the plaintiff made extensive alterations in his premises, which necessitated new gas-fittings and a larger meter. Accordingly he applied to a person named Bates, who was the agent of the company, for the purpose of supplying internal fittings, the company themselves laying down the service-pipes from the main. On the 10th of May the company laid down a service-pipe of more than extra length, part of which was imperfect, the imperfection being caused, as was alleged, by screwing it to the main. In the evening a great smell of gas was observed, and the gas-fitter employed by the plaintiff having sent his servant, Sherrard, he, having exhausted other means, got a lighted candle for the purpose of finding the place of escape and investigating the cause, for which purpose a small trap-door was opened in the floor of the shop, covering one of the joints of the pipe. Shortly after it was

opened Sherrard approached it with a lighted candle, as he stated, not for the purpose of testing, but to close the trap-door in order to allow a customer to pass out of the shop. As he stooped down to close the door the lighted candle came in contact with gas issuing from a flaw in the pipe, and an explosion of a serious character immediately followed. It should be added that the plaintiff sued really as a trustee for the Liverpool, London, and Globe Insurance Company, with whom his premises are insured, and who paid the amount claimed by the plaintiff immediately after the explosion.

The defendants case was that they were only liable for the service-pipe as far as the outer wall; that their servant who had carried the defective service-pipe under the floor of the shop was unauthorized to do so; and that as the explosion was caused by the negligence of the plaintiff's servant, he was guilty of contributory negligence.

His LORDSHIP, after stating the facts of the case to the jury, left to them the following questions:—First, was the escape of gas occasioned by a defect in the pipe; if so, then was that defect existing at the time the pipe was supplied by the company, or was it caused by any improper handling when it was laid down. Assuming that the escape of gas arose from improper handling, was there negligence or absence of reasonable caution and prudence on Sherrard's part, in carrying a lighted candle under the circumstances.

The jury, after an hour's deliberation, returned their verdict in writing. As to the first question, they said the escape of gas was caused by a defect in the pipe; as to the second, that that defect was in the pipe when supplied; to the third question, they returned that there was carelessness on the part of the company in not sending a man, or their own foreman, to test the pipe; to the last question, that there was negligence on the part of Sherrard. They, therefore, found a verdict for the plaintiff, assessing the damages at £279 1s. for the amount of the sum insured, and £125 for the other injuries suffered.

Leave was given to the defendants to move the court above.

DUNDEE GAS ARBITRATION.

(*Before* HENRY HAWKINS, *Esq., Q.C., and* THOMAS HAWKSLEY, *Esq., C.E., Arbitrators; and* G. POWNALL, *Esq., Umpire.*)

(*Continued from page* 591.)

ELEVENTH DAY—TUESDAY, JUNE 1.

Provost *Hay* recalled, and examined by Mr. LLOYD.

It was well known in Dundee that there was in the new company's Act a clause prohibiting anything which would interfere with beneficial competition. It was also known that something had been done by the two companies, as between themselves, which practically interfered with that competition. It was the cause of continual discussion and objection. It was known in Dundee that, in the new company's Act of 1846, there was that clause prohibiting amalgamation—in fact, anything which would unduly interfere with beneficial competition—and that it had been practically evaded by an agreement or some arrangement between the two companies. That was one of the reasons which induced the corporation to take up the question of gas. Dock Street is one of the principal streets of the borough. The traffic is increasing rapidly, and in time we shall require to remove these crossings, one for the railway company and one for the gas company. The Harbour Trustees have jurisdiction over the whole of that portion south of Dock Street. Works are going on to a large extent, continually extending and improving the harbour accommodation, so much so that there is a question between the railway company and the harbour authorities as to a use of a portion of that land by the railway company. We are now before the Board of Trade. It is, in fact, dangerous to the public, the traffic going on there. They are merely there on tolerance at present. We have carried on these works since the 11th of November. The price of gas has been kept up as we found it, because we had to provide for a high dividend until the arbitration was disposed of. The clause making us pay the last ascertained dividend if the annuities are not paid by a certain time, was one reason which induced us to keep up the price; but I think the public will not stand it, seeing that it is both bad in quality and high in price. In my judgment, supposing the companies had still continued to carry out the works, and the transfer had not taken place, the same result would necessarily have come about. The high price has grown with the increase in the price of coals. If they put up the price in respect of paying more for the material, I should think it stands to reason that if the cause goes by a reduction in the price of coal, the price of gas would necessarily fall. I know that the payment to be made is by annuities. I have been able to borrow a large sum, and, in fact, have had offers of much more than I required, at 4 per cent., upon the dues of the harbour trust, and the police upon the assessment, and this gas commission appointed under the Act of Parliament. They are local securities within the borough itself, and are quite secured. There is no difficulty, as far as I can see, in the working as to the appointment of a judicial factor, and it is an additional and summary mode of securing the party in addition to the general law, and is found to work effectively in Scotland.

Cross-examined by Mr. DAVISON: The Harbour Trustees borrow on mortgage or bond, so that the lender gets his money back again on six months notice. I think the Dundee Water Company are earning about 9½ per cent. We found it expedient to give them 10 per cent.; 10 per cent. is their maximum. They are to be paid by an annuity under the agreement. In dealing with the water company we had many considerations to induce us to settle the transaction without going into a parliamentary contest and a heavy arbitration. We had no power to force purchase. The judicial factor was the best way to secure the annuitants that could be devised. There is a contingent-rate in the gas, but there is not in the water. It is a rate upon the consumers.

By Mr. HAWKSLEY: There is a general assessment to any extent. Parliament has given them power to make an unlimited charge.

Mr. LLOYD: Not upon the consumer, but there is an auxiliary water-rate, supposing there is a deficiency of the fund—a domestic water-rate first.

By Mr. HAWKSLEY: In the case of water we have a power to fix the price upon the occupiers of house property to any amount sufficient to meet the obligations of the commissioners. The water-rate is an assessment for water to any extent required.

By Mr. DAVISON: I was examined as a witness about Mr. Brown's land. The value of property is rather decreasing just now. It was falling in 1868. It had risen wonderfully six or seven years before that. I should think, having regard to the 40s. at the time of high price, Brown's land would not be worth more than 27s., taking the same proportion, now. I said at the time that if I was owner of that land I would not sell it under two guineas. The land at that time was partly filled up.

By Mr. LLOYD: Brown's land was near Mr. Guthrie's factory, joining it, and would have been valuable for the extension of those works. It was also close upon a railway. There was a strong competition between the Caledonian and North British for ground at both ends of the town, both parties scheduling all the profits. Mine was a seven years lease.

Mr. *Granville R. Ryder*, examined by Mr. LLOYD.

I am the managing director of the Lands Improvement Company and the Lands Securities Company in London, and have had considerable experience in the value of investments. I deal with rent charges in Scotland as well as England. They are secured upon lands, and the principal repaid by instalments, so that it works out at 25 years. The difference of rates for investments of that class in England and Scotland is about a quarter per cent., in dealing with insurance companies, in favour of Scotland. I have seen the Act giving the security for these annuities, and, looking at the effect of it, it is a perfectly well-secured investment. I should think it would sell for 4 per cent. in the open market. In debentures, which are a charge upon the land, we borrow money upon the security of the aggregate of our mortgages, and there we have a similar sort of security to this, which enables a receiver to be appointed, which is analogous to a judicial factor. In England we can borrow loans upon our debentures at 4 per cent. on less terms than three years; from three to five years, at 4¼ per cent.; and from five years, at 4½ per cent. The rate of interest upon debenture stock on a perfectly good railway line is 4 per cent. We would expect to get something more for a debenture, for the reason that it may be paid off, and that it is not a permanent investment. The great object of railway companies now-a-days is to convert their debentures into debenture stock, so that there a security which is in the nature of a perpetual investment has a pull in the market; it is considered a better investment.

Cross-examined by Mr. GATES: The company of which I am managing director borrow upon the debentures. We have no debenture stock. We borrow at three, five, and ten years. Of course, the length of the term for which we borrow makes a difference in the price. We lend money on debentures, upon mortgages of land. We are now paying 4 per cent. for bonds under three years; from three to five years, 4½ per cent.; and from five to ten years, 4¾ per cent. I have had no experience as to how the judicial factor is put in motion. It would take some little time to recover your dividend by that process, no doubt. I have not considered how long it would take, nor the expense that would be incurred. I do not know of any companies in Scotland that have raised any money on debenture stock, or that have any debenture stock at all, except railway companies.

Mr. LLOYD: Suppose you have got all the security which can be got with a property, say a mortgage, do you think that it weakens the security to have a power in case of default—to have a receiver appointed?

Witness: I should say not. It is a power existing in every mortgage, and is, in fact, considered an additional security.

Mr. *William Anderson*, examined by Mr. PHILBRICK.

I am a member of the Institute of Accountants and Actuaries in Glasgow, and of the Glasgow Stock Exchange. I am the auditor of the Glasgow Water-Works and of the Clyde Navigation Trust. I have had considerable experience in dealing with securities in Scotland. I think the security given by the Act under which these annuities are proposed to be charged would realize a price to yield the purchaser 4 per cent. I came to that conclusion about thirteen years ago. The Glasgow water annuities are redeemable annuities of the same kind as those proposed to be given by this Act. There are two kinds—4½ and 6 per cent. stocks—both yielding 4 per cent. We have had an order to buy them for the last three months, and we cannot get them. There are two kinds of heritable security. If you borrow upon land, you will not get just now more than 4 per cent. upon it. It is sometimes as low as 3½. Then there is house property, which is always ½ per cent. higher than land. The present rates are 4½ per cent. On an average of the last ten years, the house property in Glasgow yielded about £4 13s. per cent. My experience is that these companies can borrow at a less rate in Scotland than in England. Local investments of that kind are in favour among the investing public of Scotland. They like to know the property in which they are investing their money. I have been a judicial factor myself upon occasions, and have never known of any difficulty in appointing or working that office. It is precisely the same mode of relief the gas companies in Glasgow have under their bill, and it is adopted as the best mode of realizing their securities or investments to the annuitants or mortgagees.

By Mr. HAWKSLEY: I do not think any public company in Scotland ever had occasion to resort to that; but under that Act the judicial factor has such powers that I do not think there would be any difficulty at all. He has all the powers that the commissioners have themselves.

Cross-examined by Mr. DAVISON: I do not know of any case of a judicial factor got by a shareholder against the company. The judicial factor that I have a knowledge of is appointed by the court to look after some trust estates, and he is recouped out of the estate. As trustee on estates I have had many lawsuits in Scotland, and then we have got paid all the costs. The average rate for North British debentures is £4 9s. 9d., and that company does not pay a dividend even on its ordinary or preference stock. I do not know what they are borrowing money at now. The North British got power to issue about £850,000 debenture stock, which was issued at 4½ per cent., to pay off some of their pressing liabilities. Their 4 per cent. debenture stock is now selling at £89, and the 4½ per cent. at £99. The Caledonian 4 per cent. debenture stock is selling at £90. I should not think they are giving more than 4 per cent. for debentures for mortgage just now. These securities vary with the price of money. It is when money is plentiful, and prices in the market low, that the big companies are enabled to put out their debenture stock.

By Mr. HAWKSLEY: I would not care whether I invested either in the Glasgow gas or the Glasgow water; they are both equally good.

By Mr. DAVISON: The rate that has generally ruled in Scotland for money on landed securities is 4½ per cent. I have seen it as low as 3½, but that is exceptional.

Mr. DAVISON: Is £12,000 a year derived from these securities, backed, of course, I mean by the contingent-rate, as good, in your opinion, as £12,000 a year from mortgages on land?

Witness: Dundee remaining as it is, it is so. The court of which I have been judicial factor would not allow me to invest in such security. The court have not got over the old system; they confine us to heritable securities, and, I believe, Consols. I think that is quite as good, in the circumstances that I have mentioned.

Mr. LLOYD said there was a point to be cleared up with respect to the bad debt account. He believed that had been prepared; the result was to be given as a part of Mr. Barlow's evidence.

On Mr. DAVISON's suggestion, Mr. Barlow retired with Mr. Guild.

Mr. LLOYD said, with reference to the accounts, as furnished by the commissioners themselves, of the working since the matter had been in their hands, access was given to the books, and the accountant on the part of the

company had had full permission to examine into the whole matter. He was going to call Mr. Macrae, the manager, for any purpose that his evidence might be important for in the course of the inquiry; and more especially to show how this state of the accounts, as worked out in the commissioners own experience, was consistent with their case as presented before the arbitrators with respect to the result of the company's working.

Mr. DAVISON denied that the accountant whom he had sent to Dundee had been allowed to see the books.

Mr. HAWKINS said he thought that, under the circumstances, before Mr. Davison was called upon to cross-examine Mr. Macrae, he should have an opportunity of inspecting the books.

After some further discussion relative to the access to the books,

Mr. POWNALL said the arbitrators were of opinion that the subject might now drop. It was understood that Mr. Macrae was to be called, and that Mr. Davison was not to be called upon to cross-examine him until he had had an opportunity of examining the books.

Thomas G. Barlow, Esq., recalled, and examined by Mr. MICHAEL.

Since I was here last I have have had an opportunity of examining into the condition of the bad debts. I found that the sums stated in Mr. Guild's account are the sums that have actually been written off as bad, but that there remains a large outstanding debt, for which no allowance has been made. I find that in the first of these four years—1865—the outstanding debts were £370; that amounted to 8¼ per cent. on the uncollected money. In the last year that sum had increased to £750, or 12·7 on the uncollected money. Now, Mr. Ritchie tells me that it is perfectly impossible to make any estimate of what that £750 is going to produce. They are only in process of collection, but, till the means of compelling payment is exhausted, it is impossible to ascertain what they actually are. In 1864 the amount left due was £4499; in 1865, £4640; in 1866, £4806; and in 1867, £4901. All these are taken, except what is written off as bad debts.

By Mr. HAWKSLEY: That is the total amount of debts outstanding at the end of each financial year. On the whole the balance between the sums brought forward has increased from £370 to £750, so that the average would be something short of £200. Under the Act the company is to collect its own debts; they are not handed over to the commissioners. Mr. Guild suggests that the proper mode of treating that is to make a rule-of-three sum of it. If the arrears in the first year were £4449, and they are now £7871, and the bad debts in the first year were £215, that would give you £371 as the bad debts for the last year, instead of £309. The four sums—£215, £224, £242, and £309—are the sums actually written off as bad debts.

By Mr. MICHAEL: I find the per centage left due against the company in 1865 is 23·9, as against 29 in 1868. I have inquired into the question of the new service-pipes. The only book the company have been able to put in my hands has been the memorandum-book, which contains certain information for the use of the directors at their monthly meetings. It seems that in that book, as I am informed, the number of meters in use was brought forward from time to time, without deducting off the meters that had ceased to be used until near the time when the company were about to transfer their works to the commissioners.

By Mr. HAWKSLEY: One set of figures, taking the same period in the four years, gives an increase of 1301 meters. Another set, taking them at the end of the financial year, gives an increase of 1365 according to the memorandum-book. But it appears that, just before the transfer to the commissioners, they took down and brought into store a large number of meters, amounting to 908, and it appears that from those 1350 meters that appear by the memorandum-book to have increased, the 908 must be deducted. There is a paper that was given by Mr. Mathews, the treasurer of the company, to Mr. Stiven, tending rather to confirm my statement.

By Mr. DAVISON: It is dated Sept. 1, 1868. It would appear from this that there was an actual decrease in the number of meters of 52 in 1868, and an increase of only 61 in 1867. I found, on looking at the service-pipes account in the ledger, instead of being £106 odd, as Mr. Guild states it, it is really £286, and it is reduced to £106 in this manner: the service-pipes that are laid throughout Dundee, I believe, are cast iron, and the cost of these service-pipes is charged in the service-pipes account; but an entry has been passed, at the end of the year, transferring £180 of this account to the main-pipes account, apparently on the ground that these service-pipes, being cast iron, should properly have been charged to the main-pipes account, which is a capital account. I apprehend that the fact of their being cast iron makes no difference whatever—they are service-pipes in all senses of the word; they are 1-inch pipes that are used throughout Dundee for the underground service-pipes, instead of wrought-iron ones, which rapidly decay in that soil.

By Mr. HAWKSLEY: We have got a copy of the book containing "Allocation wages." There the total cost of labour for service-pipes and gas-fittings appears to be £405 15s. 5d., and off that, at the end of the account, there is a transfer to D. Fairweather and Akoss, for service-pipes to meters, £104. Then there is a further transfer of £150 from service to main pipes. These figures do not exactly agree with the £180.

Mr. STIVEN: They are in addition to the £180.

By Mr. HAWKSLEY: The wages expended on the old meters was £427 11s. 7d., and on the new meters for the year only £17 13s. 5d. I am not disposed to make any alteration in the figures I have put down for the repairs and renewal of service-pipes. I am looking at the very small number of new meters that apparently must have been fixed. Of course, taking their account of 1300 meters as having been added in the four years, and deducting from that the 908 meters brought into store, it leaves, after that, only about 200 meters fixed. According to this account, there was an increase of 61 in one year, and a decrease of 52 in another. I do not think that fact casts doubt upon the account. No doubt, if Dundee had been flourishing as in previous years, there would have been a considerable increase.

By Mr. MICHAEL: I find that the £772 10s. which I have set down as the annual future depreciation of works, plant, mains, and service-pipes, will, at 4 per cent. compound interest, amount in about 14½ years to £15,056, at which I have taken the depreciation. The effect of that is, the depreciation may be taken at that amount, being equivalent to an average of 14½ years of their life.

By Mr. HAWKSLEY: The sum of £1820, which I have set down as the annual depreciation of works, plant, mains, service-pipes, and meters, will, at 4 per cent. compound interest, amount in ten years to £22,916. I then find that the £1047 for annual depreciation of meters will, at the same rate, amount in 6¾ years to £7860, at which I have taken those depreciations. I am accustomed, in all estimates that I make for rating purposes, to put risks and liabilities at 1 per cent. upon the rental. You employ a large number of workmen, and those are not men who understand scientifically what they are about, so that every operation of theirs is attended with considerable risk.

Cross-examined by Mr. DAVISON: The cashier's report gives, at given times, the total number of meters at work. The information we have in that is not a correct report. Taking it on the 31st of May of each year, which is the financial year, it shows 1365 in the four years, or 341 per annum. That book is a statement which, taking it at the 1st of September, give an average of 325 meters. I have got a paper given by Mr. Mathews to Mr. Stiven. I have not been able to reconcile that document with the book. I do not rely on either. It is conceded that the book shows, if accurate, an increase of 1300 meters in four years. I claim, upon the paper before me, 900 from that, because I understand from Mr. Stiven that these were meters taken down and brought into store, and that they have not been in use. [Witness referred to the book.] I find on the last sheet, November 11, "Meters out on the 13th of May, 1868, 16,156." Then "Ditto returned, not being in use, 733." That book shows there is an increase of 1300 meters in 1868 upon the number of 1864. I agree that if the service-pipes were pipes for new consumers, they should be carried to capital account. I repeat that the sum allowed for the 1-inch cast-iron pipes was properly charged to service-pipes, and you have transferred it to main. I carry it a step further by seeing what customers you had, and all I can find is that you spent £17 in fixing meters for new consumers. You would never lay a 1-inch main-pipe. I do not know that of the mains that have been valued there are 15,447 yards of ¾-inch, and 17,104 yards of 1-inch.

Mr. HAWKSLEY (to Mr. Macrae): Are those very small cast-iron pipes, in the nature of mains, run out to the extremities of the town for the supply of public lamps?

Mr. MACRAE: I am sorry to say that they run sometimes the whole length of streets.

Mr. HAWKSLEY: Then they are longitudinal pipes, playing the part of service-pipes?

Mr. MACRAE: Longitudinal pipes running the length of the streets.

Cross-examination resumed: According to this private book there is an item of meters out, May 31, 1868, 16,156; ditto returned, not being in use, 727; ditto sent out, 274; balance, 453, and a net of 15,703 in one month. It seems that up to July, 1868, there had been no deduction for meters that had been returned. In September the number of meters returned decreased. The uncollected debts in 1867 amounted to £467 9s. I do not know of any better way of getting your account for gas paid than by cutting off supply. These arrears were taken upon the revenue for the period. This 8·2 per cent. in the first year was on a revenue of £8000, and the 12·7 per cent. in 1867 was upon £12,000. The total revenue in 1864 was £18,960, and in 1868, £27,545. It is impossible to tell how much of the £370 or £750 debts are bad. It is usual to make a valuation of doubtful debts, and do what the Dundee Gas Company did with the £500. These sums in Mr. Guild's accounts are bad debts, and are written off as such. Many companies go beyond that, and make an estimate of what are doubtful; and, if they afterwards recover anything, they credit the account with it.

Mr. HAWKSLEY here informed Mr. Gates that he had made, with his accountant's consent, the arrangement that they should give the arbitrators the amounts of the rentals and discounts for fourteen or fifteen years. The arbitrators had the amount actually collected; the difference between the two would be the amount lost. That could be turned into a per centage, and it would be found what, according to the working of the company, was the actual rent.

Re-examined by Mr. MICHAEL: I have not gone into the fourteen or fifteen years, but the four years, and I find there is a continually increasing amount of uncollected debts, according to the figures I have represented. Looking at this book, up to a certain date it is called, "The number of meters that are in use." They then alter the form of account, and say, "The number of meters that are out," and bring out a total sum, in May, 1868, of 16,156. For the first time, in September, 1868, they begin the deduction of 681 not in use.

Mr. HAWKSLEY: That is 261 per annum, on an average of 8½ years.

Mr. GATES observed that the number of new tenants was represented by the number of new meters sent out, not by the average.

Mr. MICHAEL said that Mr. Lloyd, himself, and Mr. Philbrick had been considering the best course to pursue in order to save time with respect to the books, and they had put the books in now for the investigation of their accountant, and had prepared statements which they thought would materially facilitate the labour, and would put the arbitrators in possession of the comparative statement of the working in the six months, and also of the other six months remaining in the year.

Mr. *B. M. Macrae*, examined by Mr. MICHAEL.

I am the manager of the gas-works at Dundee, and now manage both concerns. I was the manager of the old company's works. I entered on that office on the 10th of January, 1867. There was then no other manager. My predecessor was Mr. Kay. I understand he had gone out of office three months before I came. I found the draughtsman in possession of the works. I made some few changes in the mode of applying the coal to the retorts. I have got indicated upon the station-meter 10,990 feet of gas from a ton of coal. I have not examined whether the station-meter correctly registers the quantity made. The illuminating power of the gas which I have made during the last year of my acting as manager is upwards of 26 candles. That has been tested by a flat flame—the union jet. By the Argand we got from 21 to 24 candles of the same gas. From the 11th of November to the 10th of April the gas made for the commissioners was just similar to that made for the company. The cost of coal, as near as I can remember, during the last half year has averaged 18s. 5d. per ton. The coal was somewhere about £1 2s. 11½d. in the company's year. The former has produced the same quality and a rather less quantity of gas. I am not satisfied as to the registration of the station-meter.

By Mr. HAWKSLEY: I think it is about 90 cubic feet per ton less registered on the station-meter.

By Mr. MICHAEL: The unaccounted coal during the company's year was 200 tons. There is some coal used in steam-boilers when we want quicker steam than we can get by using coke, and there is some used in my own house and office. It forms part as making up the average. Respecting the diminution of 4s. 6½d. in the coal in the last half year, when the commissioners were about to purchase coal, I was at that time manager of the company's works. I was consulted regarding it, and, knowing that the coal trade was depressed at that time, I saw that the coalmasters were particularly anxious to retain their connexion. In consequence thereof I saw (from verbal offers and statements I had got) that we could get our coals cheaper even than the then lowest current rate, and I recommended the commissioners, on these conditions, to purchase a large supply, which they did. The cost of coal which we are about to use for the remaining half year will be greater than for the last six months, because there were a number of balances of old contracts belonging to the companies, which I had not been able to get cancelled, that nearly all remain to be delivered. I was not allowed to take delivery of these, lest it should

form a question in this inquiry. The average ensuing cost will run between 20s. and 21s. I am quite sure I could not purchase the same quantity and quality again at 18s. 6d. The purchases were made at 18 months prospective delivery, and usually in that case the coalmasters are not so willing to quote so low a price. During the company's last year the unaccounted-for gas amounted to over 25 per cent. I attribute it to several causes. In Dundee we have a very great number of idle service-pipes, some of them in a very bad condition. We have an immense quantity of wall pipes—some idle, some occupied—many of them being in a bad condition. Our levels are very irregular; we supply a very high district, and our street-lamps, I am satisfied, consume more gas than what we get paid for; and, of course, there is the under registration of some of the meters. But I attribute the chief cause, in addition to the ordinary leakages from main joints, to the extended service-pipes and defective service-pipes. The highest initial pressure, when the mills are all lighted, and are sending out the greatest quantity of gas, is 19/10ths. The largest in the upper parts of the town is as high as 50/10ths. That would very largely increase the consumption of lamps not regulated. That pressure on the ordinary jets used, I find, to be nearly double. When we reduce our pressure to 7/10ths after twelve o'clock at night, then I do not expect that all the lamps are consuming more than the quantity taken on the average, because the lower parts are under the average. Supposing I had the means placed at my disposal as I thought fit, I should expect to be able, in the course of a few years, by altering the mains, removing many of the idle service-pipes, and making many other modern appliances, to check the pressure from ascending—perhaps to reduce it to 20 per cent. I never got it under 19 per cent. That was at Airdrie. It would entail a large cost to carry out the improvements I suggest. We have a large amount of small mains, which are mains and not service-pipes, some being as low as ¾ inch, 1¼ inch, and 1½ inch. They are good in the upper parts of the town, but not in the lower, where they are becoming softened. In the latter part the soil is composed of saline matter, and that seems to act very directly upon the iron. That applies both to the large and small mains. No doubt breakages occur which are not at once discovered, and therefore great leakages result. I should say the amount of new service-pipes applied last year would not exceed 100. There was nothing charged to consumers for putting in services, unless it went beyond a reasonable sum. Some small sums were charged. A large number of consumers live on common stairs, where there is a common pipe to supply them. One service-pipe sometimes supplies a dozen consumers.

By Mr. HAWKSLEY: We ought to give service-pipes at the average cost of from 7s. 6d. to 10s. each, but I think that many of them in Dundee cost a great deal more. Going through the passage and along the back of the buildings, I would not be inclined to give more than 5s., taking it as each consumer, because one service-pipe often supplies many customers. We do not make the connexion between this hand-pipe and the meters; the plumbers and fitters do that in every case.

By Mr. MICHAEL: The mains are chiefly laid one on each side of the street. The streets are not districted. We have as many as five or six mains sometimes in a street, including both companies. This half year has been a very good one with respect to secondary products—exceptionally so in comparison with the last year. The sulphate of ammonia has risen in price from £12 10s. to £19. We have sold all that we had got from £17 to £19. The naphtha has doubled in price. We do not sell ammoniacal liquor, but convert it into sulphate. This half year, moreover, represents the main bulk of what we derive from secondary products. We did not make much naphtha or sulphate of ammonia until October, so that, to a very great extent, into one half year are crowded in secondary products the receipts almost for the whole year.

By Mr. HAWKSLEY: We have not storeage for a large quantity of ammoniacal liquor.

By Mr. MICHAEL: We have worked 171 days. In that period we have averaged 76 tons of coal a day. Looking at the working of last year, we expect to use an average of 36 tons per day during the remaining 194 days of the year. I consider we have no ground to give away. All we have got is necessary for our purpose, and at certain seasons of the year we have every pole of it occupied. I suppose that is the case at this moment. If some portion were taken away without reconstruction of the works, we should be put to expense and trouble. The largest number of retorts I have employed in the two works together is, I think, 162, and 108 in the old works in one given day. We have worked both concerns together, in order to ease one as necessity might demand. The highest consumption in one day was upwards of 900,000 feet.

Mr. HAWKSLEY said he thought nothing could be made out of the combined working unless the two cases were tried together, which was out of their power.

Mr. HAWKINS (to Mr. Michael): Mr. Macrae, as I understand, really has been put in the box chiefly because you were challenged to put him into the box by the other side.

Mr. MICHAEL: Quite so.

Mr. HAWKINS said another reason was because the commissioners felt the necessity of producing their books. He suggested whether it would not suit the purpose of both parties better if as much of the examination as possible could be deferred until the examination upon the accounts had taken place.

Mr. MICHAEL said he was placed in considerable difficulty by the arbitrators having accounts placed before them which required much explanation, and he was endeavouring to explain away figures which might be used against him. Acting on the hint given him, he would confine himself to one other point, and trust to the re-examination to explain away anything necessary.

Examination resumed: With respect to the crossing—the railway entering into the works—I estimate the saving, as against non-necessity for cartage, at 6d. per ton. I base that on my actual experience of cartage in the district.

TWELFTH DAY—TUESDAY, JUNE 8.

Mr. *B. M. Macrae* recalled, and examined by Mr. MICHAEL.

We used some mouthpieces, front plates, and exit-pipes in 1867-68, which do not appear in the accounts that have been provided for a new retort-house. We used those in reconstructing part of the apparatus, which would otherwise have been necessary for us to have found out of revenue of that year under head of renewals. I should say the amount of those fittings, mouthpieces, &c., would be upwards of £100. There was an increase made in my salary in that year.

Mr. HAWKSLEY: £100 worth of fittings, were there only 108 retorts in action, would be more than would be due to the year itself, and that, of course, would have to be divided over a number of years, because those articles mentioned last for a very long time.

By Mr. MICHAEL: If we had not had those mouthpieces, we must have found them out of revenue in the usual course. They were required to be put on for that year, because the others were broken and worn out. It was resolved to increase my salary in May, 1868, but it was not paid till some time after that. It was somewhere about £78 7s. 8d. They increased my salary from the date of my entry into the service. I cannot tell whether it appeared in the accounts of that year. The total period I had been in service was 1 year and 142 days. I received £131 6s. That is the proportion of the old company. It was not exactly two to one.

By Mr. HAWKSLEY: A part of that £131 is not to be reimbursed by the new company. They paid their own proportion.

Cross-examined by Mr. DAVISON: I had £100 a year more for both companies. The new company's proportion was £78 7s. 8d. I have been connected with gas-works 14 or 15 years, and exclusively in Scotland. I did not find the old company's works in the state I thought they should be in. I could not find a retort-book on the old company's premises. I started one beginning with my management, and so continuing. I managed both the old and new works. Each company had a separate book. They are not separate now. We have "East" and "West" sections, and the cast refers to the new works. The book produced is the one I kept. Mr. Jamieson must have got his information, how to make out the accounts as between the old company and the new, from the books. I gave him some information as to the proportions. I do not know whether he has made use of it. When the two companies were existing as separate concerns, the new manufactured about one-half the quantity of the old; we always calculated just one-half. 12,528 tons is, no doubt, the correct quantity of coals we have worked during the 171 days in possession, reducing my average to 73 tons per day. There were 108 retorts in one day heated, and I believe that six of them would not have been required if we had had the use of our new gasholder. We had never 108, except when we were filling the new gasometer. We happened to be filling that from Christmas to New Year's Day, and that was the time we required most gas, and I believe if we had had the new gasholder built earlier we should not have required those six. As far as I know, the service-pipes were lumped together in the accounts, and did not appear as separate items. There are three retorts in a bed at these works. That is the best number. The coals consumed were about one-fifth sea-borne. They were landed at the docks, and carted. They were put free on board at Bo'ness. We lightered them ourselves, paid the freight, the discharging of the ships, and the cartage. They had scarcely any coal when I went there, and they were obliged to make contracts at unusual prices. I do not know if I prepared a speech for Mr. Harris. We provided "for giving an abundance of gas at all seasons." They had not the means before I went there. I found "many districts insignificantly provided." Some of them were improved, and some were not. There were a few new buildings erected in Dundee during the first year. It increased the number of our customers. I tried to improve the mode of carbonizing the coal. During my first year it was said by the book-keepers and directors that there was a large decrease in the expense of working generally. I have no reason to doubt it. The paper produced is my writing. It says: "There were various circumstances connected with the past year that told against the old company." We had to pay a very high price for coal. Gas coals were higher that year than ever they were before. I do not know what year that speech was due to. I wrote it for Mr. Harris; he supplied me with part, and part which he did not understand he wanted me to put out in language suitable to the circumstances. I do not know if it was written for the year ending June, 1868. "The stokers wages were that year higher than they had ever been in Dundee; the trade of Dundee was dull; factories on short time consumed less gas;" and "the general dulness of trade operated against the interests of the company." As to residuals, "the naphtha was never sold so low," and we did not get "over one-third the price per gallon" that we had got in former years.

Mr. HAWKINS: That speech must have been for the year 1868.

By Mr. DAVISON: As to the "Unaccounted-for gas," it is the difference between what is carbonized and what is used. We get a certain quantity of coal; we take stock on the 31st of May, and we add to that stock all the coal which we get during the year. We take stock again on the 31st of May, and we deduct the difference. Then we see what coal we have used, and if that does not harmonize with the result of the other calculation, there is so much unaccounted for which is charged to those accounts. Then all the extra weight we get from the coalmasters goes without any account, which, in the company's year, amounted to 200 or 300 tons, besides those 200 tons.

Re-examined by Mr. LLOYD: That is a difference in the weight. I came here in March at the instance of the gas company, but was not called. The commissioners have brought me now. The books say there has been a larger amount of retorts previously to that year when the 108 were in use. I do not think £36 for the repairs of all the service-pipes for a year is anything like a reasonable amount. I am not aware that the speech which I put into form for Mr. Harris was ever delivered. If the price of coal changes, the cost will be increased.

Mr. *G. A. Jamieson* recalled, and examined by Mr. LLOYD.

The account I prepared, based upon the commissioners statement, and comparing it with the working of the companies, is correct, to the best of my knowledge and belief. At the request of Mr. Hawksley and Mr. Guild I have gone over the abstracts of the consumers ledgers, with a view of making up a statement which shall show the total rental of the company, and the total cash received. The difference between those two must of course consist of the allowances which were made for discounts by the company, of the bad debts which they had written off, and of the sums which are yet to be recovered. On the figures, of course I and Mr. Guild are one. There is no doubt about them. We have taken the period from May 31, 1856, to May 31, 1868. For that period there were outstanding at the 31st of May, 1856, debts amounting to £4006 17s. 9d. The rental for gas in the interval of those years amounted to £232,133 6s. 8d.

Mr. DAVISON: I thought Mr. Barlow was to settle this matter.

Mr. HAWKSLEY: I asked for a fact instead of a speculation.

Witness: Those are the facts which I am now giving. The revenue was £232,133 6d. 8d. for gas, and £12,217 8s. 7d. for meters. These three charges, which are the actual charges to be accounted for, amount to £248,357 13s. Cash actually received has been £228,750 0s. 5d.; discount actually allowed, £8128 9s. 7d. These two items, being the sums which have been received, with the discount, amount to £236,878 10s. There remains due, but accounted for, £11,479 3s., and of that there has been actually written off, as ascertained bad debts, £3607 14s. 6d., and there remains to be recovered £7871 8s. 6d. The result of that is, that the bad debts actually ascertained and written off on the gross rental on the average of those years has been 1·47 per cent. But to this will have to be added whatever loss may be sustained in realizing the £7871 8s. 6d. which was left outstanding in 1868. It is to be observed that the amount outstanding in 1868 is largely in excess of that of any other year. Taking it from 1864,

the amount left outstanding of the revenue of the company at the close of each balance was in per centages as follows:—22·3, 20·6, 20·8, 21·9; and the £7871 represents 27·3 of the revenue.

Mr. HAWKSLEY: That is, there was 6 per cent. more outstanding at that period than had been usual?

Witness: Yes; so that the facts speak for themselves.

By Mr. HAWKSLEY: That would have to be divided over the 12 years. The period begins at 1856-57, which was a very severe crisis, and the amount of bad debts written off in 1857 was 1·08. The next year it was 2·82. The amount written off the last year of the company on the morrow of the crisis of 1866 was 1·08, exactly the same as 1857, and, if the same thing was to hold good, the year following would show nearly 3 per cent. of bad debts written off—I mean in 1868-69. The 1·47 is certainly below what I should take as an average, and the difference will fluctuate between that and 1¾—probably 1½ will be about it; and, if you think of a revenue of nearly £30,000 collected from a manufacturing population occasionally in bad circumstances, that is not by any means an extravagant calculation. It does not come to a very large sum on such a large revenue. I am quite satisfied that, by any test you can apply, it is below the amount of Mr. Barlow's statements. The company gives as a fact £309, and I raise it by this calculation to about £460 or £470.

Cross-examined by Mr. DAVISON: The statement I have given is made up from the commissioners books from Nov. 11, 1859. The £2226 2s. 4d. there is a result arrived at after deducting £500 for sinking-fund, £1500 for depreciation, £383 6s. 7d. expense of loans, and £803 9s. 4d. as cost of stores in suspense. I have dealt specially with the item of valuing stores, £365. I do not know where the item of £1234 2s. 2d. for stores expended on capital account is. That does not appear on my books at all. That is my adjustment. The whole £3479 is debited. There is, for new meters, £75 13s. 6d.; interest on mortgages, £858 6s. 1d.; interim annuities, £5154 10s. 3d. The whole of these, and a great deal more, are deducted before the £2226 2s. 6d. is arrived at. According to my accounts, the operations of the commissioners up to April 30, 1869, show a surplus of £12,404 18s. 2d. In their books for that 5½ months, £2947 6s. 11d. is the total item for wages. My statement, showing the result of the operation of the commissioners for the year to Nov. 11, 1867, gives £2053 18s. 7d. for wages. I deduct from the former amount the items included there which are included under other heads in the statement. Collectors are, no doubt, included in the salaries; there is no special head for them. The figure I have got under the head of salaries, No. 10, is £786 17s. 3d. That includes £70 10s. 8d. collectors wages; therefore I have got it twice over. The item of horses and keep has been debited to the wages account, and again distributed over the other items. The item of £167 4s. 8d. for coke is, I see, entered "To wages" here. It is a portion of the £2947 6s. 11. It is not also taken off before you arrive at the £1055 8s. 2d., which is the proceeds of the coke. There is an item of £126 2s. 3d. in the £2947 for repairs. Wages are debited to repairs. I have put the repairs on buildings and apparatus at the same figure, £163s. 7s., on the third page of the account; therefore it is twice over. There is an item for labour in chemical products of £86 17s. 6d. Wages are entered the same way there, and the revenue account is debited £2028 9s. 9d. That is after deducting the £86 odd for wages. That again is a double charge. The purifying account shows £181 12s. The wages seem to have been included there. As to coals, there is an item of firemen's wages here of £1294 9s. 2d. That is not included in my statement. I give you the coal at £11,718 5s. 3d., and it is £14,000 in the books here. In the printed account they put "Coal account, cost of coal, and firemen's wages, £11,744 16s. 4d." I have gone quite wrong from not abstracting properly the wages account. I did not know that it included those items. In this case I am not wrong; I have not taken the company's books at all for this matter. I have not taken and dealt with that £11,744. I have taken the actual cost of the coals, pure and simple. There is the £12,760 4s. 8d. actual cost. They had sold some small coals to the amount of £17 16s. 2d., and they had in hand £2292 0s. 9d. These items, forming a deduction, amounted together to £2309 16s. 11d. Deducting that from what they paid for coal, not including wages, leaves the sum which I have stated, £10,450 7s. 9d. The £2947 includes the £1381 16s. for wages. I did not know that those wages included them.

Mr. DAVISON: I did not for a moment say that you did. That is a very small matter, you know; but that is £615 12s. 1d., which has been charged twice over.

Cross-examination resumed: What I had got to do here was to give a statement of the revenue of the commissioners, and in estimating that I found a large sum standing against the year for the expenses of borrowing money. I considered that it would be improper to charge the whole of that expense against this one year, and I hold now that they might borrow that money for five years at a time, and that therefore it would be fair to spread the expense over five years. The company, or whoever did this business, if they borrowed the money, must have paid the expense of borrowing it. I have examined the carbonizing book. The total of the new and old companies is 136,808,000 cubic feet. The coal carbonized for the two undertakings in the same period is 12,529 tons. That produces £26,846 12s. 5d. of revenue yearly. These figures will, no doubt, now have to be corrected to the extent of £612.

By Mr. LLOYD: That will be £13,000, instead of £12,402.

By Mr. DAVISON: I think the estimate of coals I took in dealing with the year was 6756 tons. I find the amount the companies have been paying during the last year for their coals, and I find what the commissioners have paid during this estimated year, and the difference is rather more than 3s. a ton, and I take 3s. a ton as being within the mark. I cannot tell the quality of the coal taken over from the company by the commissioners. I have guessed that—viz., 1098 tons at £1262 7s. 6d. I have taken that as against the commissioners at 23s. That is 1098 tons out of the 12,528. I have got the coal account period to April. I then take the period from April to November, £8038 16s., which, upon the quantity which is left of 7630 tons, is at 21s. per ton, whereas the period of five months and a half is at 18s. 5d. That I did on instructions that the commissioners have ordered that better coal should be used from the 10th of April, to cost 21s. per ton. I put £1900 for the wages. That is on the assumption that the £2053 was right. It will have to be altered in proportion; about £500 should be deducted from that, if £600 is taken off the other.

By Mr. LLOYD: The reason I put £1900 instead of £2053 is because it is in the summer months.

By Mr. DAVISON: The gas revenue I have arrived at is £15,882 for the unexpired part of the year. I have got the estimate for the whole year, which was 212 millions, and the estimate assumed there would be 133 millions of that made up to the 30th of April; 186 millions were really made. I therefore found that the reality exceeded the estimate about 2½ per cent., and I added that on to the remaining part of the year. I make the quantity sold in the remaining period to be 60 millions. The figures I gave you before were gas made. The gas sold in that period was 217,200,000, and then I take 2,500,000 at 4s. 5d., as supplied to the Police Commissioners, and 57,490,000 at 5s. 4d., as supplied to the public. The £462 19s. 10d. is the item in which the £80 for mortgages is included. I have given £30 for the 6½ months. Out of that £462 there is, for printing and stationery, £177 3s. 8d. I do not know whether that £177 includes all the new books and forms, and everything they have now, but I will concede that it does.

Mr. DAVISON: You are debiting to five months the whole cost of that which is to be utilized for years to come?

Witness: I am quite ready to admit that there must be extra expense.

By Mr. LLOYD: I analyzed these accounts under considerable pressure of time.

Mr. *J. W. Guild* recalled, and examined by Mr. DAVISON.

I have examined the commissioners books from the 11th of November to the 30th of April. The balance of the revenue account shown for that period is £2226 2s. 4d. That is after deducting sinking-fund, £500; depreciation, £1500; expenses of loans, £383 6s. 7d.; stores expended on capital account, £1234 2s. 2d.; stores in suspense, £803 9s. 4d.; expense of valuing stores, £365, and new meters, £75 13s. 6d.; the interest on mortgages, £858 6s. 1d.; interim annuities, £5154: total, £10,874 7s. 11d.; which gives a revenue made up in that way of £13,110 10s. 3d. That is compared with £12,404 18s. 2d., which Mr. Jamieson shows on the face of his account, and it is accounted for by the £615 12s. 1d. error in wages twice charged, and £80 expenses of mortgage. The £15,882 15s. for the residue is the same as Mr. Jamieson's. The meterrent, coke, tar, and naphtha are the same. It results, therefore, in the £49,506 12s. 8d. The coal account here is the same as that appearing in the commissioners books, not the same as in Mr. Jamieson's statement. I have taken the actual amount expended on coal, *plus* the wages carried to the coal account, as appearing in the commissioners statement. I have nothing against wages; but I have the coal account £11,744, representing, as it does in the printed account of the commissioners, coal and firemen's wages. I take the quantity of coal which, according to Mr. Jamieson's estimate, will be consumed, amounting to 7630 tons, at the average price for the preceding 5½ months—at 18s. 8d. That amounts to £7122. Mr. Jamieson takes 21s., and I take the actual thing on the 5½ months. I took the salaries at £800. That might, perhaps, be made a little less; in that the salaries include the secretary, which was not really a charge upon the old company. That includes the secretary to the commission at £300 a year. There was no secretary kept by the company; there was Mr. Mathews, the treasurer. There was no officer like Mr. Thornton in the companies before the transfer. He gets £300 a year.

Mr. LLOYD: I understand the new company's secretary had £180.

By Mr. DAVISON: The total shows £11,777 6s. 10d. as the net expenditure of the period, which, added to the £17,540 7s. 5d., is £29,317 14s. 3d. That taken from the figure on the other side leaves £20,188 18s. 5d. as surplus revenue for the year of the two companies for the first period. There is £13,110 10s. for the second; £7088 being the difference between the two.

By Mr. HAWKINS: It is the balance of the surplus income of the two companies for the whole year.

By Mr. DAVISON: Mr. Jamieson's figure for the £7088 8s. 2d. is £5161 15s., making a difference of £1927 3s. 2d. between us. The surplus revenue of the old company, according to the corrected revenue account produced to the company, was £9740 1s., and the revenue of the new, appearing from their last accounts, was £4202 3s., after deducting interest and rectifying income-tax. I add to that surplus, as I have done in the other, the directors fee of £57, making the new company's surplus £4259 3s., the two together amounting to £13,999 4s., and the proportion for the old company being £69 5s., as against £35 5s. for the new. Applying that proportion, I find the £20,188 18s. 5d. of surplus revenue brought out by me would give to the old company £14,031 4s. 7d., and to the new £6157 13s. 10d. That is the same as brought out by Mr. Spice and the other parties who took my rectified balance-sheet as the basis of their statements.

Cross-examined by Mr. LLOYD: There is nothing included in the £7122 for coal for wages. The aggregate amount of wages for the two companies for the period before the works were taken over was £4157 6s. 9d. According to that principle it is now £4869. I have specially excluded the wages of the secondary products. The wages of the old company include the wages of the secondary products. The aggregate of wages, without the secondary products, in the company's time was £4157 6s. 9d. Then if you add the secondary products, that would be £865, as affecting the old company. I do not know what the new company's secondary product wages may have been. I think they must be included. Then that is £5022 as against £5021. You have to produce £42,729 worth of gas, instead of £41,077—that is, £1600 worth additional. My total expenditure, actual and estimated, of the commissioners amounts to £29,317 14s. 3d. The combined expenditure of the last year of the companies was £33,606 3s. 6d. The coals would make all the difference.

By Mr. DAVISON: I have reduced the £493 for general expenses to £382, on the basis that the stationery and the £80 for mortgages ought not to appear as against the company in arriving at an estimate. I agree to the results brought out by Mr. Jamieson in regard to the rental and bad debts, with one exception. I agree that for the 11 years the bad debts amounted to 1·47, and that there was a balance uncollected at May, 1868, of £7871. That gives to the gas-rental 27·3, but I think an important element is the £4682 9s. 11d. of arrears at the commencement of the period—viz., May, 1856. That also gives exactly 27·4; so that the only addition, if it is a fair one, to be made to the 1·47, is any excess of bad debts upon the balance remaining at May, 1868, distributed over the 11 years.

Mr. HAWKINS inquired if any more witnesses were to be called.

Mr. DAVISON and Mr. LLOYD both replied in the negative.

Mr. LLOYD said there were some papers to be put in. He had the parliamentary bill for amalgamation. He supposed he might use it.

Mr. DAVISON: Oh, yes.

(To be continued.)

REDUCTION IN THE PRICE OF GAS AT WIGAN.—The directors of the Wigan Gas Company have given notice of a reduction in the price of gas from the 1st of July last, to 3s. 6d. per 1000 feet, within a radius of one mile from the company's works, and 4s. 7d. beyond that radius, with a discount of 10 per cent. to small consumers, and 20 per cent. to consumers of 150,000 cubic feet per annum or upwards, if the accounts are paid within one month after delivery.

ORIENTAL GAS COMPANY.—The directors of the Oriental Gas Company, Limited, have appointed Mr. T. Randolph Mellor their consulting engineer to the company in London. It must be especially gratifying to Mr. Mellor to receive this appointment, after honourably fulfilling the duties of engineer and manager of the undertaking in India for upwards of seven years.

Miscellaneous News.

THE WATERS OF LONDON.

[From the Registrar-General's Returns.]

Perhaps there is no matter more important to the people of London than its water supply. Air and water are necessaries of life, and on their purity the public health very much depends.

Both these elements contain impurities which every one desires to see excluded, and this desire has been to some extent realized. Smoke in the air we breathe has been diminished under an Act of Parliament; the water is no longer taken from the Thames at the mouths of the London sewers, into which hundreds of thousands of water-closets emptied.

And the consequence is that the cholera, which ravaged the metropolis so fatally in 1832, and again in 1849, and again in 1854, was much less fatal in 1866; indeed, it was only very fatal in East London, where the water reservoirs were then in close connexion with the river Lea, charged with sewage.

It was proved beyond question by the analyzed returns of this office that the fatality of cholera, when epidemic, bore a very constant ratio to the quantity of sewage in the water of the several companies. The Thames companies afterwards ascended the river to points above Teddington lock, and some of them provided reservoirs and adequate filtering-beds, so as to command the means of supplying a somewhat hard but filtered water.

It became necessary to watch over the purity of the London waters, in connexion with the meteorology and the weekly returns. The duty was undertaken, and most zealously discharged, by Dr. Robert Dundas Thomson, F.R.S., down to the date of his death, on Aug. 17, 1864.

The medical officer of health of the City of London then offered to supply the Registrar-General with his analyses,* but the Registrar-General deemed the analysis a matter of so much importance that he brought it under the notice of the Lords Commissioners of Her Majesty's Treasury, who appointed, first, Dr. Hofmann, F.R.S., and subsequently Dr. Frankland, F.R.S, to this responsible office.

When it is recollected that the water companies, like the gas companies, enjoy the monopoly of a necessary of life, that their water-rents in 1866 were £799,536, that they can thus employ and pay eminent scientific witnesses to advocate their interests before parliamentary committees and royal commissions, the responsibility of the office of an independent chemical analyst becomes evident.

The Royal Commission on Water Supply justly says: "Whatever may be our difference of opinion with respect to some of the conclusions, we cannot place too high a value on the independent analyses of the water supplied to London, published monthly, in the comprehensive and important reports of the Registrar-General."†

These independent reports, it is believed, have been as useful to the engineers of the water companies, in conducting their very difficult operations, as they have been to the public.

The ill effects of sewage in water are illustrated by the experience of the Broad Street pump, which, under ordinary circumstances, yielded a popular water, but in an epidemic season poisoned hundreds of men, women, and children. The pump destroyed its hundreds, the Thames and the Lea their thousands under similar circumstances. The evidence on this head is conclusive.

The diffusion of the water-closet system up to the sources of the Thames and its tributaries has again produced uneasiness, which is unallayed by the evidence of engineers and chemists, who have no professional means of determining the effect of sewage water on the lives of the population of London.

Mr. Leach, engineer to the Thames Conservancy Board, thinks that‡—

> The contamination has been very much exaggerated. In the country towns (on the Thames basin) there is no regular system of sewage generally. The majority of the houses drain into cesspools, and really there is no very large outfall in any case except at Windsor; there a more perfect system of drainage has been carried out, and there is a most offensive outfall. * * * The matter which is passed out of the drain floats about in the river there to a very great and very disgusting extent. * * * Two miles, or even a mile, below that I could see no traces whatever of the sewage.

This excellent engineer very simply infers that what he could not discover had ceased to exist; just as a well-known chemist, for similar reasons, asserts that sewage matter disappears after a run of ten miles. Mr. Leach is asked—

> Was the sewage all broken up and destroyed?—Yes; and taken by fish, and so on.
>
> Is it the habit of fish to take up and matters of that kind?—Yes. You generally see persons fishing close to the outlet of a drain. I think that the operation of the Act of 1866, which prohibits the discharge of sewage into the river, will have a very beneficial effect. If some such provision had not been passed, I can quite understand that, as the system of water-closets was extended, and a more perfect system of drainage was carried out, the river would rapidly become much more contaminated; but the powers contained in that Act will, I hope, put an effectual stop to the pollution of the river.

Unfortunately, the restriction is not yet in operation, and it will only extend to the main stream, and to the tributaries three miles up the stream; all beyond is free. Mr. Leach does not advert to the fact that the supply of sewage is very variable in dry and stormy weather, and that the appetites of fish and the absorbing powers of weeds cannot be relied on to meet all exigencies.

The evidence that large quantities of sewage enter the Thames is overwhelming, and it is, therefore, not necessary here to refer, as the commissioners do, to recondite sources similar to the Liebfrauenberg vineyard, the Fontainebleau forest, and the Sauer hop-ground, for the nitrates and other products which Dr. Frankland recognizes in the Thames as the irrefragable evidences of "previous sewage contamination."

It is a fact that London was supplied daily in May last with about 453,577 tons of Thames water, consisting of 453,454 tons of pure water, and 123 tons of salts of lime, and other ingredients from various sources. These other matters Dr. R. D. Thomson and Dr. Frankland, both Fellows of the Royal Society of London, have called "impurities." And in the weekly tables it is usually stated as a simple fact that 100,000 tons of the said water contain, besides pure water, from 27 to 41 tons of foreign matters in solution. It now appears that Sir John Thwaites, Sir Benjamin Phillips, and their colleagues, consider this expression of a fact "unphilosophical;" and where authorities differ on a question of "philosophy," the Registrar-General can only leave the decision to the scientific world.

The pollution of wells and rivers from which cities draw their waters often produces no ill effect on health that is detected; at other times their noxious qualities produce epidemic explosions. Like nitro-glycerine, they are often harmless, sometimes destructive. To sustain that waters containing sewage are "generally wholesome" beverages, is a most dangerous doctrine.

After studying every week for many years the effects of the Thames water on the diseases of three millions of people living in London, the conclusion is, that the purer the water is the safer it is; that the Thames water, without sewage, is as good as any of the large river waters; that it requires purification by storeage and filtration; that, as mountain air is finer than town air, so for all purposes the pure soft water of the hills is twice as useful and twice as salubrious as the waters of the Thames; but that London must be satisfied with the best Thames water it can get, until another Royal Commission is found to be more successful in carrying out the object for which the recent commission was appointed—namely, "for the purpose of ascertaining what supply of unpolluted and wholesome water can be obtained by collecting and storing water in the high grounds of England and Wales, either by the aid of natural lakes or by artificial reservoirs at a sufficient elevation for the supply of the large towns, and to inquire into the present water supply to the metropolis, and whether there are other districts, in addition to the high districts of England and Wales, from which a good supply of unpolluted and wholesome water can be obtained."

The Registrar-General begs to call attention to the annexed letter of Dr. Frankland.

Royal College of Chemistry, July 10, 1869.

Sir,—Having read the report of the Royal Commission on Water Supply, which has just appeared, I beg to offer one or two remarks concerning those portions of it which reflect upon the reports that I send to you monthly on the quality of the metropolitan waters.

Whilst the commission express a very high opinion of the value of these reports in the following sentence:—"We cannot place too high a value on the independent analyses of the water supplied to London, published monthly, in the comprehensive and important reports of the Registrar-General," they at the same time take exception to two of the principal data of my analyses—viz., "total solid impurity" and "previous sewage contamination."

With regard to the first term, you are aware that it was not initiated by me, but was employed in their analytical reports to you by my two predecessors, Dr. Dundas Thomson, F.R.S., and Dr. A. W. Hofmann, F.R.S. In adopting the term, however, I thoroughly agreed with those gentlemen in regarding it as a suitable designation for the solid matters contained in the London waters, and I mention its authorship only to call to your recollection that it was sanctioned and used by the two eminent chemists in question.

I regard these solid constituents as impurities, because—

1st. They are utterly useless for all purposes to which potable water is applied in London, and this appears to be the view of the Royal Commissioners.

2nd. They act injuriously in several of the processes for which the London waters are employed.

It is true that many water drinkers prefer hard water to soft; but they also prefer, and for the same reason, the polluted water of shallow wells, because it has to them a sharper and more agreeable taste than water which contains but a minute amount of solid matter; it may at least be assumed, then, that these solid matters are useless, even if quite innocuous. Now it appears to me that all useless matter added to useful matter is an impurity; thus, if chalk be found in milk it is properly deemed an impurity, though innocuous; and if so in milk, why not in water?

It must be remembered, however, that but a very small proportion of the water supplied to London is used for drinking purposes. A very large proportion is employed for washing, and a considerable one for manufacturing purposes. In its application to these uses the presence of the large amount of solid matters, giving hardness to the London waters, is undoubtedly injurious; indeed, the Royal Commissioners strongly point this out in the following words:—"There is no doubt that this evidence is conclusive and cogent as to the great advantage of soft water over hard for washing, and, with some few important exceptions, for general manufacturing purposes."

It appears to me, therefore, that a material in water which is always useless and frequently injurious is correctly described as an impurity. Neither do I think that the case of atmospheric carbonic acid, mentioned by the Royal Commissioners as analogous, can strictly be so considered. The presence of carbonic acid in the air is absolutely essential to life; deprive the atmosphere of its minute amount of carbonic acid, and our globe is rendered uninhabitable by such forms of life as now exist upon it; but the use of distilled water in Her Majesty's navy proves that potable water may be freed from solid matters without becoming thereby unfitted for human consumption. Carbonic acid is a useful, nay essential constituent of the air, but solid matters are useless, and in some respects injurious constituents in water supplied to towns.

With regard to the second datum in my analyses—viz., "previous sewage contamination"—I regret that the Royal Commissioners should have founded their strictures almost entirely upon mere statements of opinion unsupported by facts. Many of these statements are founded upon the misconception that "previous sewage contamination" does not include contamination from solid manure and other similar refuse animal matters, although I have repeatedly stated, in my reports to you and elsewhere, that the term is an abbreviation for "previous sewage *and manure* contamination." In the face of an overwhelming number of analytical facts showing that waters of known purity, draining from almost every variety of uncultivated and unmanured soils, do not exhibit previous sewage contamination, the commission had only before them three facts which favoured the conclusion at which they have arrived. These were, first, the presence of minute quantities of nitrates in the unmanured soil of the Liebfrauenberg Hills, and of the forest of Fontainebleau, mentioned by M. Boussingault; second, the formation of nitrates from putrid yeast, observed by Dr. Angus Smith; and, third, the occurrence of nitrates in the chalk wells at Watford, mentioned by Dr. W. A. Miller. We will consider these cases *seriatim*.

The observation of M. Boussingault, that the earth of unmanured ground contains traces of nitrates, does not appear to me to have any substantial bearing upon the point at issue, because rain water is well known to contain traces of nitrates and of ammonia, the latter being converted into nitric acid in contact with some varieties of soil. As rain falls both upon manured and unmanured land, it is obvious that both must be liable to contain traces of nitrates unless they are removed by the action of vegetation; it is even possible that, in dry showery weather, a certain amount of concentration of nitrates may here take place, owing to the evaporation of water from the surface; but in our moist climate it is scarcely possible that such a concentration can go on to any considerable extent. Inasmuch as the nitrates and

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* The Registrar-General was at that time unacquainted with the following facts, which have since transpired. In a published correspondence (Parliamentary Return No. 574, session of 1867) between the Board of Trade and the East London Water Company, the secretary of the company writes as follows:—"The directors have for many years past co-operated with the other metropolitan water companies in procuring their respective supplies to be periodically analyzed by a high independent authority (Dr. Letheby, who is *the medical officer of the City of London*, has been for some time past selected for this duty)." And further, in the evidence before the Rivers Pollution Commission (River Lea, Q. 418), Mr. Greaves, the East London Company's engineer, is asked by Professor Way, "Does Dr. Letheby furnish an analysis of your water every month?" The answer being, "Yes; for our private knowledge and information and justification."

† Report of the Royal Commission on Water Supply, pp. 93, 94. For the justification of this opinion of the commission, see subsequent pages, 254—9.

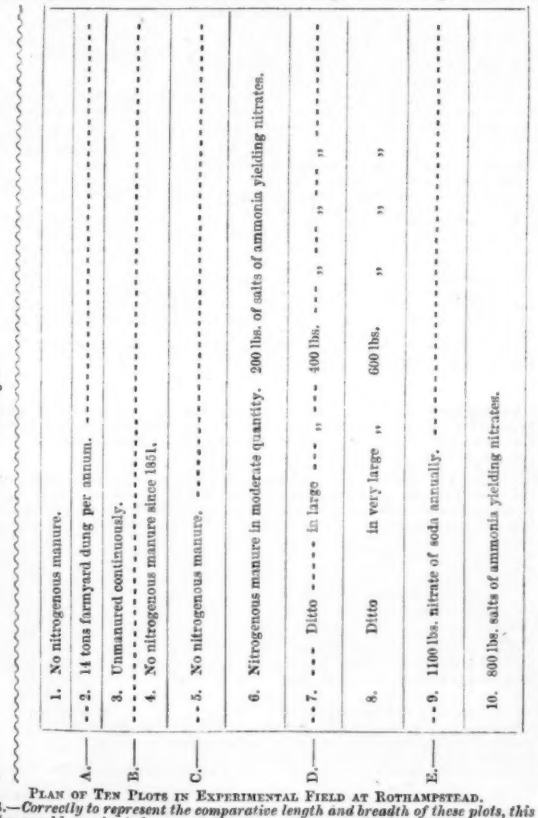
‡ Report of Royal Commission on Water Supply, p. 88.

ammonia in rain water are allowed for in my calculation of previous sewage contamination, the objection founded upon M. Boussingault's observation obviously falls to the ground, unless it can be shown that rain water, percolating through such soils, becomes contaminated with a larger proportion of nitrates than I have allowed for, in which case my correction-constant would require to be increased. The Royal Commissioners appear to have lost sight of the fact that such a correction is always made in my reports to you, and that no water is pronounced guilty of previous sewage contamination unless it contains more nitrogen in the shape of nitrates, nitrites, and ammonia, than that contained in rain water under these forms.

The second fact, on this side of the question, before the commission was the production of nitrates from putrid yeast, observed by Dr. Angus Smith, Now, in the first place, yeast is a very exceptional kind of vegetable matter; it occupies a position on that border land where the animal and vegetable kingdoms meet, and where the biologist finds it very difficult, if not impossible, to draw the boundary line; secondly, putrid yeast not unfrequently contains grubs; and, lastly, it can scarcely be contended that yeast, or any material closely allied to it, can play any important part in the contribution of nitrates to Thames water.

The third alleged fact, adduced by Dr. W. A. Miller, is evidently brought forward under a misconception of the term, "previous sewage contamination." He says: "The waters from Watford, which come from chalk wells, *where there can be no suspicion of previous sewage contamination*, always contain nitrites." Dr. Miller here confines previous sewage contamination strictly to sewage, and makes no mention of the drainage of the water in the Watford wells from manured land, or from the cesspools and dumb-wells which absorb into the chalk the excrements of the people of Watford and St. Albans. I have never used the term, "previous sewage contamination," in this restricted sense, but have always spoken of it as extending to all kinds of decomposed animal matter, whether contained in sewage, privies, cesspools, or the solid manure applied to land.

This, so far as can be ascertained from their report, was the whole of the evidence of fact before the Royal Commission; but I have recently become acquainted with a case of the production of nitrates, which, at first sight, appeared to show that these salts could be generated, in very large quantity, in continuously unmanured land. During the past 25 years Messrs. Lawes and Gilbert have been making very important experiments at Rothampstead on the continuous cultivation of wheat on the same land without manure, and with different kinds of manure. As the different plots submitted to these experiments are separately drained, this appeared to be, in addition to those of which I have already availed myself, a good opportunity for testing the drainage water from continuously unmanured land, as well as from land to which various manures had been annually applied, and Messrs. Lawes and Gilbert kindly undertook to collect for me samples of water draining from the different plots. On submitting these samples to analysis, I was surprised to find that they all contained large quantities of nitrates, and, what was still more remarkable, the drainage water, from a plot which had received no manure for 25 years, contained a larger proportion of nitrates than the water from the adjoining plot which had been dressed with 14 tons of farmyard dung per acre every year during the same time. These results, so different from any I had observed elsewhere, led me to visit the experimental plots, when the cause of the anomaly was at once apparent. The experimental plots constitute a single field about 352 yards long; the plots themselves are strips of this field 352 yards long; some are 8 yards wide, others only 4 yards; a separate drain-pipe passes up the centre of each at a depth of between 3 and 4 feet from the surface. This surface is gently undulating, with a general inclination across the drains, but in opposite directions at the top and bottom of the field. I enclose a plan drawn to scale (¼ inch = 4 yards) of that portion of the experimental field from which the samples of drainage water were collected. The continuous lines show the furrows which bounded the separate plots, the dotted lines indicate the position of the drain-pipes, whilst the letters A, B, C, D, and E, denote the particular drains from which the samples were taken. The manure treatment is also marked upon each plot. A glance at this plan, and still more at the field itself, shows how very improbable it is that the drainage water of such long and narrow plots should be kept separate, as there is no provision whatever underground for keeping the water of each individual plot from mixing with that of its neighbours. In fact, leaving the nitrates altogether out of the question, it was found on analysis that the chlorine (which being an element could not be generated) had travelled from the farmyard manure plot 2 into the drain B of plots 3 and 4; and again, a large quantity of the chlorine of the muriate of ammonia applied to 6, 7, and 8, had travelled into plot 9, which had received no chlorine in the manure applied to it for the last 25 years. The analyses give indications of an underground current flowing in the same direction as the numbers of the plots. It is needless to add that, under such conditions, no reliance whatever can be placed upon the assumption that the separate samples of water really represent the distinct drainage of each individual plot. On the contrary, both the conditions just mentioned and the analytical results indicate that the water flowing from each pipe represents rather the general drainage of the whole field, the latter having for the past 25 years received on the average a very ample dressing of nitrogenous manure, since the 13 acres which it contains receive annually the following nitrogenous manures:—


Hedge.
1. No nitrogenous manure.
2. 14 tons farmyard dung per annum.
3. Unmanured continuously.
4. No nitrogenous manure since 1851.
5. No nitrogenous manure.
6. Nitrogenous manure in moderate quantity. 200 lbs. of salts of ammonia yielding nitrates.
7. Ditto in large " 400 lbs. " " " "
8. Ditto in very large " 600 lbs. " " "
9. 1100 lbs. nitrate of soda annually.
10. 800 lbs. salts of ammonia yielding nitrates.
A.
B.
C.
D.
E.

PLAN OF TEN PLOTS IN EXPERIMENTAL FIELD AT ROTHAMPSTEAD.

N.B.—*Correctly to represent the comparative length and breadth of these plots, this plan would require to be extended horizontally to nearly four times its present length.*

14 tons farmyard dung,
1000 lbs. rape cake,
5200 lbs. salts of ammonia,
1100 lbs. nitrate of soda.

As salts of ammonia are rapidly converted into nitrates in nitrifying soils such as that of the experimental field, it follows that we have here an ample source for the nitrates found in these drainage waters.

From what has just been said, it will be seen that nitrates may be derived from the nitrogenous salts applied to land in artificial manures; the amount of these salts so used is, however, far too small to require consideration, even if we were to assume that the plants to which they are applied as a costly manure make no use of them.

Up to the present moment, therefore, there is no evidence whatever of the innocence of any sample of water which has been found guilty of previous sewage or manure contamination on analytical grounds. I have now examined upwards of 1000 samples from all parts of the United Kingdom, and have not yet met with a single case of clear analytical guilt which has not been sustained on further investigation. It is true that my verdict has repeatedly been met with vehement protestations of innocence, but further investigation always proved that these could not be sustained. The other day a gentleman brought to me two samples of well water for examination; I reported both as exhibiting great previous sewage contamination. He protested that it was impossible, as the waters were bright and sparkling, and enjoyed a high reputation. A week later he informed me that the sources of contamination had been discovered; one of the wells was situated close to a large cesspool, the other received the drainage from a dog-kennel.

I find that during its percolation through 5 feet of gravelly soil, 97 per cent. of the combined nitrogen of London sewage is converted into nitrates. Indeed, it is admitted on all hands that sewage and animal refuse generate abundance of nitrates, and the recent observations of Dr. Palmer, chemical examiner to the Indian Government, on the formation of nitre in India,* show that even in hot and dry climates the production of nitrates equally depends upon the decay of animal refuse. He says: "The Sorawallah (collector of nitre) goes about the village examining the small surface drains which issue from holes in the mud wall usually found around native dwellings and their cow-houses. The nitre-producing parts of India are more densely populated than England; the villages are large, and are made up for the most part of mud houses surrounded by a mud wall, which generally encloses the dwellings of a whole family, including uncles and aunts and their families, as well as grandparents and grandchildren; every family will have at least one pair of plough oxen. The only drains from these houses are the small surface ones before alluded to, and the only fluids which pass by these drains are urine and the small quantity of refuse water brought to the house for culinary or drinking purposes; these drains open on to a small open plot of ground, where the drainage diffuses itself, and is rapidly dried in the sun." As evidence in favour of the theory that the production of nitrates in India is dependent essentially upon the presence of animal excrements, and especially of urine, Dr. Palmer states:—

"Firstly, that no other known source of nitre exists.

"Secondly, that nitre is found only in and near populous villages, that it continues to be found on the same spot of ground so long as it is inhabited, and gradually ceases when a village is deserted."

I am therefore of opinion that the presence of nitrogen in the form of nitrates in water, in quantity above that which can be derived from rain water, is safe and reliable evidence of the anterior pollution of that water by animal organic matters. On the other hand, the absence of nitrates is not absolutely conclusive evidence of immunity from this pollution. I have repeatedly mentioned the imperfection of the evidence on this side of the question; nitrates are removed from water by the action of aquatic plants, and they also disappear when the water putrefies. It is probably by the first of these processes that, in summer, they are more or less completely removed from the East London Company's water, which is often stored in reservoirs for a long time before use. I have also found that the addition of fresh sewage to previously contaminated water destroys more or less completely the evidence of the previous contamination. Thus the evidence of the previous contamination of the London water supply is sought for in vain in the discharge from the metropolitan sewers—the nitrates present in London water are absent from the fresh sewage, which rarely contains a trace of nitrates. It is to this circumstance that the reduction in the amount of nitrates in some streams, after the addition of fresh sewage, is due. Previous sewage or manure contamination, as determined by analysis, is consequently, as I have already repeatedly stated, a minimum quantity; and I therefore entirely concur in the opinion of the Royal Commissioners, who have minutely discussed this part of the question, that it does not represent the *comparative* freedom of different samples of water from anterior pollution. Nevertheless, where analysis indicates this excess of nitrogen in the shape of nitrates, nitrites, and ammonia, the water stands convicted of previous pollution to the extent *so indicated*. Shall we reject this ordeal because polluted waters may pass through it without conviction? Do we reject criminal prosecution as a safeguard to society, because the evidence notoriously fails, in some instances, to convict the guilty? In neither case can it be said that the guilty and convicted are unfairly treated, because a certain number of guilty but unconvicted escape.

At the risk of being tedious, I cannot close this letter without calling your

* *Journal of Chemical Society*, vol. xxi., p. 318.

attention to what chemical analysis *can* and *cannot* tell us respecting potable water. The following sentence in the report of the Royal Commission seems to render it necessary that this should be clearly stated, as the commissioners themselves obviously entertain opinions respecting the powers of chemical analysis which the latter are not at present able to ratify. They say (page 101): "In the present state of chemical science, analysis fails to discover, in properly filtered Thames water, anything positively deleterious to health." Now, this statement applied to *filtered Thames water* is eqully applicable to London sewage, or to the dejections of persons suffering from cholera or typhoid fever. Chemical analysis has failed to discover anything positively deleterious to health in these matters, in their most concentrated condition, and it is not, therefore, likely that analytical research will be more successful when applied to them after dilution with the water of the Thames. Nevertheless, men like Mr. Simon, F.R.S., the medical officer of the Privy Council, and Dr. Parkes, F.R.S., Professor of Hygiène in the Army Medical School, who have carefully and impartially investigated the subject, tell us that these substances are capable of communicating disease to those who drink water contaminated with them. In his evidence before the Royal Commission Mr. Simon has truly stated the case where he says (page 76): "There are dangerous qualities of water supply with regard to which, so far as I know (but I do not speak as a skilled chemist), chemists are totally unable to measure, even to demonstrate the fatal influence that a water may have. A water may be, for instance, capable of spreading cholera, but chemists be unable to identify the particular contamination which produces that effect." "It ought to be made an absolute condition for a public water supply that it should be incontaminable by drainage." "Supposing that sewage is discharged from one of the sewers, say at Windsor, I believe it would be absolutely impossible for chemists to discover it seven miles lower down the river, having regard to the volume of water in the river. But the practical sanitary question is different. Supposing tape-worm eggs to be sent into the river with that sewage, would those tape-worm eggs be alive seven miles down? Or supposing cholera discharges to be sent into the river, or the discharges of typhoid fever, and assuming (which is a frequent pathological opinion) that the respective contagia of typhoid fever and cholera are living germs, would those germs be alive seven miles down? It is not a question whether a chemist would find out the organic matter, so much as it is a question whether those particular molecules would still have their property seven miles down. I cannot say that they would not." "I could only detect them by their effects." Dr. Parkes says (page 67): "I have made a list of diseases, all of which are occasionally communicated by means of water—not solely communicated by water, but occasionally. For example, typhoid fevers, of which I have collected about 23 instances of local outbreaks of severe typhoid fever, and some six or eight more, the particulars of which I have not got, are known to me, arising from water impregnated with typhoid sewage, or possibly with simple sewage."

It cannot be too widely known that chemical analysis is utterly powerless to detect any matter positively injurious to health in any of the forms of animal refuse which go to contaminate water. In proof of this I may cite the report of a well-known chemist, whose evidence as to the perfectly harmless character of Thames water appears to have had considerable weight with the Royal Commissioners. Of a sample of sewage of average strength flowing into the Thames, this chemist says: "The sample of liquid is a very weak solution of carbonate and sulphate of ammonia, with a little calcareous and organic matter and common salt. The total amount of these matters is only about 56 grains per imperial gallon, and *therefore* the liquid is perfectly harmless to animal and vegetable life." The use of chemical analysis in the investigation of water for sanitary purposes lies almost exclusively in a totally different direction. It is only by bringing to light the previous history of potable water that chemistry can help the custodians of the public health. Even the discovery of actual sewage in water has only a sanitary significance on the same ground—it only shows that human excrements are in the water, it throws no light upon the noxious or innocuous character of those excrements. That they may be comparatively innocuous is proved by the fact that thousands of our fellow-countrymen habitually drink their own sewage which has percolated through a few feet of earth; that they may be noxious is rendered at least very probable by the decimation of the same people when a case of cholera or typhoid fever is imported amongst them.

It is singular that whilst many regard with indifference the presence of nitrates in river water, all agree that they are very suspicious when found in the water of shallow wells. I am unable to coincide in the former opinion, however generally it may be held; indeed, if compelled to choose between a river water and a well water containing equal proportions of nitrates, I should prefer the well water, because I find that percolation through 5 feet of a gravelly soil removes much more organic impurity from sewage water than does a flow of 50 miles in a river at the rate of one mile per hour. Consequently the chance of the destruction of noxious organized matters would be greater in the case of the well water.

It is for the physiologist, not the chemist, to say what influence the admission of excrementitious matters into drinking water has upon the health of the community. If his verdict is that they have none, then water analysis for sanitary purposes becomes useless; but if the accumulated experience of thirty years leads him to the contrary conclusion, then chemical analysis can aid him, by showing in a great majority of cases the previous history of the water as regards its companionship with excrementitious matters.

In conclusion, I beg to point out an error of calculation into which the Royal Commissioners have inadvertently fallen. In their observations upon the subject of previous sewage contamination, at page 92 of their report, they base some of their objections upon a comparison of the quantities of nitrates in various parts of the Thames and its tributaries. As no quantities of nitrates had been given by Dr. Odling and myself in our analyses of the waters from the Thames basin for the Royal Commission, it was not at first evident whence the numbers in the report had been derived. A reference to the analytical results showed that, at the page above mentioned, all the numbers given by the Royal Commissioners as the amounts of nitrates present are erroneous, as is also the statement that there are no nitrates in the river Kennet just above Reading. A further comparison of these numbers with the analytical results, showed in what a singular manner the error has arisen. To get the quantities of nitrates, the Royal Commissioners have taken the numbers expressing the previous sewage contamination, and, altering the notation comma into a decimal point, have regarded the number so altered as the expression of the amount of nitrates in 100,000 parts of water, thus: 3,260 parts of previous sewage contamination = 3·260 parts of nitrates. I need not say that there is no such relation between previous sewage contamination and nitrates. 100,000 parts of the head waters of the Thames contain ·358 part of nitrogen in the form of nitrates and nitrites; if this were all nitrate of potash, which would be the heaviest of all possible nitrates or nitrites, it would weigh only 2·583, instead of 3·260 as given in the commissioners report. I have pointed out this error to the secretary of the commission. I fear it is an indication that I have not explained to the commission with sufficient clearness the meaning of the term "previous sewage contamination."

There is one other matter to which it is necessary to allude—viz., the expression of the analytical results in my reports to you in parts per 100,000, instead of grains per gallon. I do not understand that the Royal Commissioners censure this mode of expressing analytical results, but at page 75 they say, in reference to these reports: "The analyses which accompany these reports show a general agreement with those just referred to. As, however, they are elaborated on a principle not ordinarily employed, it is not easy to compare them with those of other chemists." As I have frequently explained, the only difficulty in the comparison of my decimal results with those expressed in grains per gallon, consists in multiplying the former by ·7, and my chief reason for employing the former instead of the latter is the universal use, on the Continent of Europe, of the decimal method of expressing analytical results. Moreover, the degree of hardness which I employ is used throughout France. From the number of letters I receive on the subject, I know that your weekly reports are very extensively read on the Continent; indeed, it is only by a national interchange of such statistics that their maximum utility can be realized. It is, therefore, not unimportant that the statistical data should be given in a form not liable to misinterpretation. The conversion of decimal numbers into grains per gallon is a sufficiently simple process for an Englishman, but how is a foreigner to perform the reverse operation, the gallon being a measure unknown on the Continent?

You will perceive that I have confined myself in this letter entirely to the points raised by the Royal Commissioners, in reference to my monthly and annual reports to you on the metropolitan water supply.—I have, &c.,

The Registrar-General, &c., &c. E. FRANKLAND.

The following table places in juxtaposition with the reports of Dr. Frankland, those published in the name of the Metropolitan Association of Medical Officers of Health by Dr. Letheby:—

JANUARY, 1868.

Dr. Frankland.	Dr. Letheby.*
The waters delivered in London during the latter part of January by the Chelsea, and especially by the Southwark and Lambeth Companies, were in such a muddy condition as to render them totally unfit for domestic use. The Thames has overflowed its banks above the point at which the water supply is withdrawn, and, by washing the surfaces of cultivated fields, and mingling with the contents of stagnant ditches and ponds, has become contaminated to an intolerable degree. Those companies which, like the West Middlesex and Grand Junction, possess ample and efficient filtering apparatus, were enabled so far to cope with the difficulty as to send out their supply free from suspended matters. A week later, however, than the date when the samples were collected, the water of the Grand Junction Company had also become turbid, but much less so than that delivered by the Southwark and Lambeth Companies. It will be seen from a reference to the analytical tables that the Thames was contaminated at the time that the samples were taken with double the usual proportion of organic matter. Besides dissolving the soluble manure matters from cultivated fields, the recent heavy rains flushed the sewers of Oxford, Windsor, &c., dislodging great quantities of putrescent animal matters, and sweeping them into the Thames; hence the large proportion of organic carbon and nitrogen, and the great previous sewage contamination in the waters of those companies which derive their supply from that river. The West Middlesex Company's water, though well filtered and perfectly transparent, had been thus contaminated to an extent which would be produced by the admixture of one-third of a gallon of average filtered London sewage with each 10 gallons of the water. The river Lea also exhibits a very high previous sewage contamination, but at the time when the New River and East London Companies samples were collected it had not been affected like the Thames, for, although the East London water was full of suspended brown particles, the analyses of these waters show that the organic carbon and nitrogen are remarkably low for the season. The Kent Company's water was slightly turbid from yellow particles.	The Grand Junction water was turbid, and all the samples, except that of the Kent Company, contain a slight excess of solid matter on account of the floods occasioned by the heavy rains.

FEBRUARY.

Dr. Frankland.	Dr. Letheby.
The waters delivered by the New River, East London, and Kent Companies were clear and transparent, but, with the exception of the West Middlesex, all the companies drawing their supply from the Thames were delivering imperfectly filtered water on the day when the samples were taken. The Lambeth Company's water was so muddy that brightly illuminated objects could not be seen through a stratum of it 12 inches deep. The Chelsea Company's water was but little better in this respect, and the supply of both companies was, on this ground alone, entirely unfit for domestic use. The water delivered by the Southwark and Grand Junction Companies was only slightly turbid.	The water of the Lambeth Company was turbid.

The organic matter contained in all the samples of water, except those of the West Middlesex and Southwark Companies, was highly nitrogenized, and therefore probably of animal origin to a considerable extent.

The condition of the Kent Company's water delivered at the Deptford railway station on the 7th inst. presented remarkable peculiarities. It contained the very large amount of 59·2 parts of solid impurity in 100,000 parts of the water; 42 parts being the maximum, and 39·3 the mean amount observed in this company's water during the year 1867. Of the above 59·2 parts no less than 14·7 were common salt, the occurrence of which in such quantity is difficult to account for, except on the supposition that the company's wells have some connexion either with the sea or the brackish reaches of the Thames. The previous sewage contamination was also higher than that observed on any former occasion.

For the first time since February, 1867, the East London Company's water exceeds that of the New River Company in previous sewage contamination.

MARCH.

Dr. Frankland.	Dr. Letheby.
The effects of the great January flood in the Thames have now nearly disappeared; nevertheless, the water delivered by the Lambeth Company on the 4th inst. was nearly as muddy as the samples collected in January and February. The waters delivered by the Chelsea and Southwark Companies were likewise turbid, whilst the West Middlesex and Grand Junction Companies, who also draw their supplies from the Thames, delivered water which had been efficiently filtered, and was therefore perfectly transparent. The water taken from the river Lea and supplied by the New River and East London Companies was also quite transparent. The amount of organic nitrogen in the turbid waters is considerably higher than in the transparent samples; it is, therefore, highly probable that solid particles of unoxidized sewage enter into the composition of the suspended matter in the turbid samples.	The samples of the Chelsea and the Lambeth waters were turbid were drawn.

The peculiarities presented by the Kent Company's water delivered at the Deptford railway station, and noticed last month, are exhibited by the sample collected on the 2nd inst. in a still higher degree. The water was turbid from floating fibrous particles; its total solid impurity has increased from 59·2 parts in 100,000 in February to 70·2 parts in March. Nearly the whole of this increase is due to common salt, which, amounting to the very large proportion of 14·4 parts in 100,000 of water last month, has now increased to 23·7 parts.

APRIL.

Dr. Frankland.	Dr. Letheby.
The Southwark Company's water was, as usual, turbid, but that delivered by the remaining companies was in every case well filtered and perfectly clear.	No remarks.

The Kent Company's water has now returned to its normal condition. The engi-

* These reports are printed in the *Medical Times and Gazette*, and in other journals, as the returns of the Metropolitan Association of Medical Officers of Health.

neer to the company suggested to me that the abnormal state of this water, when the February and March samples were taken, might have arisen from the introduction of some impurity into the main within the Deptford railway station. We have, both of us, inspected the water-mains in the station, but without finding any source from which such impurity could have been derived. To test the matter still further, the engineer tapped the street-mains outside the station, and on the 18th inst. I collected a duplicate sample from the tapped main. On comparing the results of the analysis of this sample in the following table with those yielded by the sample taken half an hour later from the cock in the station whence the samples have been previously obtained, it will be seen that the two specimens are almost absolutely identical. There is, consequently, no ground for the supposition that the water collected in February and March last had been contaminated after delivery by the company. The quantity of common salt contained in 100,000 parts of each sample collected on the 18th inst. was as follows :—

Sample collected in railway station . . . . 8·5 parts.
Sample collected from street-main . . . . 8·9 parts.

The quantities contained in the February and March samples were respectively 14·7 and 23·7 parts in 100,000 parts of water.

MAY.

Dr. Frankland.	Dr. Letheby.
The water delivered by the West Middlesex, Grand Junction, Lambeth, New River, and Kent Companies was perfectly clear and transparent, but that drawn from the Chelsea and East London Companies mains was slightly turbid, whilst the Southwark and Vauxhall Company's water was full of suspended particles.	No remarks.

All the river waters have now attained their summer degree of purity, the active aquatic vegetation having withdrawn much of the mineral remains of the sewage poured into the Thames and Lea. By long storeage in large reservoirs the East London Company have even removed every vestige of such previous sewage contamination.

JUNE.

Dr. Frankland.	Dr. Letheby.
The long-continued drought has rendered the river waters supplied to London unusually pure. The previous sewage contamination of these waters is, on the average, much lower than has ever before been observed. The Southwark Company's water was again turbid from the presence of much suspended matter. Besides giving the water a repulsive appearance, this suspended matter is nitrogenous, and therefore highly objectionable. With the exception of the East London Company's water, which contained, however, only traces of suspended matter, the rest of the samples were perfectly bright and transparent.	All the samples were bright excepting that of the Southwark and Vauxhall, which was slightly turbid.

JULY.

Dr. Frankland.	Dr. Letheby.
The river waters supplied to London again exhibit an exceptional degree of purity as regards solid matter, hardness, and previous sewage contamination; but the proportion of organic nitrogen, representing chiefly unoxidized animal impurities, is nearly as great as usual, showing that the accelerated oxidation of the organic impurities, owing to the high temperature, is nearly compensated by the diminished volume of water with which the sewage and manure matters commingle in the Thames and Lea. The temperature of the Thames at Greenwich on the 9th inst., when most of the samples were drawn for analysis, ranged from 18·6° to 19·3° Cent. On reference to the following analytical table it will be seen that this high temperature is not lowered by transmission through the street-mains. The deep well water of the Kent Company has now a considerable advantage over the river waters in regard to coolness, its temperature being from 2·5° to 5·2° Cent. lower than that of the latter. It is to be regretted, however, that this advantage is lost, owing to the intermittent system of supply. The waters delivered by the Grand Junction, Lambeth, and East London Companies were very slightly turbid; the rest of the samples were clear and transparent when drawn from the companies mains.	No remarks.

AUGUST.

Dr. Frankland.	Dr. Letheby.
With the exception of the Southwark Company's water, the river waters supplied to London again exhibit an exceptional degree of purity as regards solid matter. In August, 1867, the average amount of solid impurity in Thames water was 26·2 parts in 100,000 of water, whilst in the current month it is only (exclusive of the Southwark Company's water) 24·5 parts. The previous sewage contamination is also at present remarkably low; in 1867 it averaged in Thames water 1416 parts in 100,000, whilst in the samples just analyzed it is only 386. On the other hand, the proportion of organic nitrogen, representing chiefly unoxidized animal impurities, is as great as usual, averaging for Thames water exactly the same in August, 1867, and August, 1868—viz., ·025 part in 100,000 parts of water, showing that the accelerated oxidation of the organic impurities, owing to the high temperature, is nearly compensated by the diminished volume of water with which the sewage and manure waters commingle in the Thames and Lea. The Southwark Company's water contains an exceptionally large amount of mineral matter, causing the total solid impurity to rise to 30·2 parts in 100,000. The high temperature of the river waters as delivered in London during July still prevailed on the 14th and 19th inst. The water delivered by the Chelsea and Southwark Companies was very slightly turbid, whilst that of the East London Company presented an opalescent or milky appearance. The rest of the waters were clear and transparent.	All the samples were perfectly bright when drawn from the companies mains.

SEPTEMBER.

Dr. Frankland.	Dr. Letheby.
The Southwark Company's water was exceptionally polluted, containing an excess of 13·2 parts of solid impurity. It was also harder, and contained more organic matter and previous sewage contamination, than any other sample of Thames water. Much of this excess of impurity is due to common salt, of which it contained no less than 13·2 parts in 100,000. The Southwark and East London Companies waters had traces of suspended matter in them; the rest were perfectly clear and transparent.	All the samples were clear when drawn from the mains.

OCTOBER.

Dr. Frankland.	Dr. Letheby.
The water delivered by the companies drawing their supplies from the Thames has suddenly changed from its summer to its winter condition. The inorganic remains of sewage and manure retained in the pores of the soil during the long late drought are now being washed into the river. On the 10th of September the previous sewage contamination of Thames water as delivered in London averaged only 604 parts, whilst on the 9th of October it amounted in the mean to 2548 parts in 100,000 of water. The unoxidized impurities of the river have also undergone a marked increase during the same period. Drawing its supply from the same source as the other Thames companies, the Southwark and Vauxhall Company has, on each occasion when the sample was taken during the past three months, been delivering a water of a strikingly different composition. The total solid impurity, common salt, and (in September and October) the organic constituents, have all been in very marked excess in this as compared with the remaining Thames waters. The proportion of common salt in Thames water delivered by the other companies during the past three months has never exceeded 3·6 parts in 100,000 parts of water, whilst in the water of the Southwark and Vauxhall Company it has been as follows:—August 19, 7·5 parts; September 10, 13·6 parts; and October 9, 7·2 parts. I have sought in vain from the engineer of the company for some explanation of this exceptional condition of the water. The admission of a certain proportion of the tidal water of the Thames at Battersea into the companies reservoirs would cause the excess of the impurities which I have observed, and consequently the matter ought to be investigated without delay. The river Lea had not, on the 9th inst., experienced a corresponding change in quality. The waters delivered by the New River and East London Companies, who draw from this river, still preserved their summer degree of purity. The Southwark Company's water was very turbid, and that of the East London Company slightly so; the rest of the samples were perfectly bright and transparent when drawn from the companies mains. The excessively high temperature which prevailed in the river waters during the summer, had experienced an average fall of 6° Cent. on the 10th inst.	All the samples were bright when drawn from the companies mains.

NOVEMBER.

Dr. Frankland.	Dr. Letheby.
The Southwark Company's water, which was exceptionally contaminated during the months of August, September, and October, has now returned to its normal condition. It does not now differ in any marked degree from the water of the other companies drawing their supplies from the Thames.	All the samples were bright when drawn from the companies mains.

DECEMBER.

Dr. Frankland.	Dr. Letheby.
The water of the Lambeth Company was turbid and milky; that of the Southwark Company slightly turbid. The samples drawn from the mains of the New River, East London, and Kent Companies contained traces of suspended matter, whilst the waters supplied by the Chelsea, West Middlesex, and Grand Junction companies were perfectly clear and transparent.	All the samples, excepting that of the Chelsea Company, were clear when drawn from the companies mains.

BRITISH ASSOCIATION OF GAS MANAGERS.

(*Continued from page 560.*)

WEDNESDAY, JUNE 2.

The PRESIDENT took the chair this day, at eleven o'clock.

The SECRETARY read the following paper:—

ON UPWARD'S SAFETY DRILLING AND TAPPING APPARATUS FOR GAS AND WATER MAINS, ETC., UNDER PRESSURE, AND FOR CONNECTING SERVICES THERETO, WITHOUT ESCAPE OF EITHER GAS OR WATER.

The object of the apparatus exhibited is to secure the following purposes, which it has been found to accomplish successfully, viz.:—

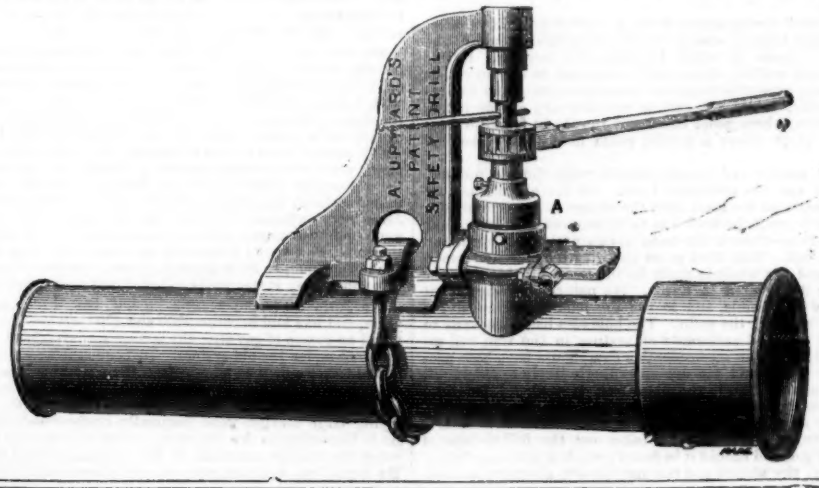
1. A perfectly sound and secure service connexion with the main, either gas or water.

2. An entire avoidance of any escape, either of gas or water, during the operation.

The principle of the apparatus is exceedingly simple. A drill of peculiar construction, working in a gas-tight cylinder, perforates a perfectly round hole; this is followed by the screw-tap (itself part of the drill), which cuts a thoroughly true thread, the drilling and tapping being, in fact, one operation. The service connexion is then introduced, without the possibility of any escape of gas, and the operation is complete.

The opening can be of any magnitude desired, and a large service can be inserted as readily and with the expenditure of appreciably no more time or force than a small one.

The action of the apparatus will be readily understood as here exhibited. The drill-post is placed in position over the place where the hole is to be



drilled, and firmly fixed by the clamp chain; it will be observed that the same clamp chain will serve for a variety of different sized mains. A little stiff clay is put round the bottom of the cylinder, that there may be no escape of gas; in drilling a water-main the escape is prevented by a washer of vulcanized india-rubber. The drill of the size required is now put into the piston, and fixed at a mark by means of a small set-screw at the side, and the drilling commences. It will be seen that the construction of the apparatus prevents the possibility of the drill deviating from the required direction in which the hole is to be bored, thus ensuring that the hole shall be perfectly true. The drill is fed downwards by the telescopic feeding-screw. This form of feeding-screw was adopted in order to allow the apparatus to work in a very confined space—a great desideratum in any apparatus of the kind. It will be observed that a spring inserted under the piston always maintains the edge of the drill in perfect contact with the surface to be cut, and ensures that the cut shall be cleanly made to the very last. This is a matter of considerable importance, especially where a large service enters a comparatively small main, in which case the drill may have cut through at the extremities of the diameter of the hole before it has begun even to abrade the surface at a diameter perpendicular to this. I will, however, recur to this point presently. When the hole is complete the set-screw is released, and now the tapping commences. The screw is perfectly tapped when the tap comes home to the shoulder, and the hole is then ready for the insertion of the service.

The next step is to remove the piston-tap and drill; they are lifted up out of the hole by working the ratchet backwards, and then the valve at the side is shut. The drill and tap are thus released and laid aside. A cap, fitting the cylinder gas-tight, is now put over the cylinder, having a vulcanized india-rubber top. Through an opening in the centre of the india-rubber is inserted the service-pipe, previously stopped with a thin wafer composed of wax and tallow. The valve is then opened, and the service screwed into its place, and the remainder of the service completed in the usual way. A little piece of tarred yarn, lighted, applied at the place where the wax wafer was inserted, at once opens a passage for the gas.

The foregoing description applies to a gas service; the modification in that of a water supply is simply directed to securing the safety of the cap under the very considerable pressure to which it is exposed, and will be at once understood by a glance at the apparatus.

The following are the practical advantages attending the use of this apparatus:—

It secures a perfectly circular hole, without which no sound connexion can be made with the service. It is evident, from the construction of the apparatus, that the drill cannot possibly deviate from the line in which it is originally set, and, were it desired, could even be made to drill an oblique hole, which would nevertheless be truly circular. A very small quantity of shaving is introduced into the main, the drill withdrawing a round button of iron. Should the iron be harder in some places than others, or the drill meet with flaws, such obstacles simply require a small amount of extra care, and are thus readily overcome in turning the feeding-screw a little more slowly. The cutters of the drill shave away the iron uniformly, and, by as slow degrees as may be necessary, make a small circular channel in the main, which is gradually deepened until a circular button is cut out; this button is held in the hollow at the bottom of the drill, and is withdrawn with it. The main is, of course, a curved surface, and this has always proved a serious source of embarrassment in the old form and method of drilling; this drill, however, cuts the iron regularly away as it comes in contact with it, any irregularity in the surface to be cut being of no moment, those parts which happen to be highest being cut away first. In this way no *burr* is formed—the inner edges of the cut are as smooth as the outer. The drill is not checked by an accidental flaw or hard place in the iron.

On the table is a specimen in which the drill has accidentally encountered a considerable blow-hole without the rest of the hole suffering in any way, so that even in such a case a sound joint was made.

The tap, being part and parcel of the drill, follows it accurately, so that there is no danger of the screw being distorted or drunken and the threads uneven, nor is there any inducement to force the tap so as to endanger the main being cracked; nor is there any risk of the tap acting as a wedge to open any small flaw, which under the old process was so apt to occur in chipping the hole and rymering it out afterwards.

Perfect security is provided against the escape of gas. The whole time the operation lasts, from the moment when the main is first perforated up to the time when the service is screwed into its place, not an inch of gas can by any possibility escape. During the greater part of this period the hole is stopped by the piston and accurately fitting tools, and, when these are removed, by a valve as simple in construction as the ordinary stop-cock. In a confined space, such as a tunnel, excavation, or subway, this is a matter of the very utmost consequence. The atmosphere is not in the slightest degree contaminated. There is no danger of ignition or explosion, and consequently open lights may be used with perfect impunity—a great contrast to the state of things under the old methods, where the most skilful workman could not prevent a very serious escape, which, in such situations as those referred to above, must be disagreeable, and would be highly dangerous to both life and property.

The small space in which the apparatus works is another great advantage. It can be employed where tapping a main by the old methods would not be attempted from want of space in which to swing the hammer. In this respect, indeed, practically nothing more can be required, as a main can be opened and tapped by the apparatus with far less disturbance than was required to lay it originally. It is not easy to conceive any circumstances likely to occur in practice, where room could not readily be found to work the apparatus in any place where a service could need to be taken off the main.

Contrast this simple, speedy, and certain process with the old method. The ground is opened and the drill-post fixed. In the old method, no sooner has the drill penetrated the main than the escape of gas commences, and continually increases until the drill has to be removed in order to take off the burr. The whole aperture in the main is now necessarily open, and the gas escaping at the full. This must go on until, with a chisel or rymer, the burr is got rid of, and the whole is ready for the tap. All this time the workman has a strong inducement to hurry. He naturally wishes to cut the burr out as quickly as possible, and to use the hammer vigorously, to the no small danger of cracking the main. The hole also has a tendency to become irregular, and want of uniformity of texture in the iron will increase all these difficulties. If an inconsiderable flaw should have been produced in the main, the rymer and tap are exceedingly likely to enlarge it, and thus probably an unsoundness in the main itself is produced, entailing waste and trouble—possibly danger by subsequent leakage. This apparatus, on the contrary, makes no burr, nor is any ryming out of the hole needed.

Again, in the old process, when the tap is taken out the full opening of the hole is discharging gas, and should it be found (which is not improbable) that the screw is faulty, the service and tap may have to alternate an indefinite number of times, entailing an escape at each change. In this apparatus, should the screw be imperfect (which is not at all likely), the service may be screwed and unscrewed as often as may be necessary without entailing any loss of gas at all. The workman also can get his finger into the hole, and feel what the obstacle is (should any occur), without any escape of gas. All this time he is in perfect comfort, and without the necessity of any undue haste. Moreover, he is not bewildered with a number of different tools; knowing the size of the hole he has to make, he has simply to put that sized drill and tap into the apparatus—all the rest of the apparatus serving for any sized hole—and the chain-clip is adjustable by dropping one or more links to any size of main from the largest to the smallest—a feature, it is submitted, of practical importance in apparatus which has to be used at a distance from home in the streets of towns and cities.

Its use in tapping water-mains is not less that that of gas. No doubt an escape of water is less dangerous than an escape of gas, but it is even more troublesome and disagreeable. There is no need, with this apparatus, to draw off the water from the mains—a process which not only may involve the shutting off of several miles of main, and considerable waste of water, but which in London never fails to surround the workman with troublesome spectators.

But a main may be tapped by this apparatus with the head of water on, and that without the loss of any water; and though, no doubt, engineers generally would as a rule tap their mains at the lowest pressure they could command, there would be no practical difficulty whatever in tapping one under any head of water which the main itself could safely be made to carry. All that is necessary in this case is to secure the cap, so that there shall be no danger of its flying off the apparatus. This is done by a bayonet lock joint, and the connecting service (in this case provided with a stop-cock) is screwed into its place by means of a small piston-rod running through the stuffing-box of the metal cap. The apparatus would also serve equally well to tap an iron tank either of hot or cold water, and that without drawing off the water or interfering in any way with its use. This would, no doubt, be a very great convenience in dwelling-houses, factories, ships, and the like, an absolute security being given against escape of water. This could be accomplished in situations where even a small escape would be a very serious evil.

Mr. H. Jones said there could be no doubt upon the mind of any person present as to the great value of the invention just described, preventing as it did all chances of accident from escapes of gas in the laying on of services. There was one advantage of the invention not alluded to in the paper, but which was of some importance—viz., that it necessitated the use of a drill. Every gas manager had suffered from the men employed on this work cutting the hole and then rymering, because of the facility with which it could be done, and there was always a difficulty in adjusting the clips for different sized pipes by the chain. If this were the only benefit of Mr. Upward's invention, it would be a very great boon to gas companies. It was impossible to exercise a complete control over the men in works were a large number were employed, and it was impossible to supervise every hole that was made. Any contrivance, therefore, which ensured the latter being done in a proper manner was a great advantage. Through cutting and rymering it was often found that old mains became cracked—the crack was perhaps almost imperceptible at first, but it afterwards enlarged and became a fruitful source of escapes of gas.

Mr. Rafferty (of Manchester) said he went through Mr. Upward's works last year, and was much struck with the instrument now exhibited, and the advantages to be derived from it, especially in preventing waste of gas. He had given some consideration to the subject since, and was happy to say that it was in contemplation to introduce the invention into the works at Manchester. One was already in his possession, and he had had some fear lest delay would occur in its use through the necessity for making the workmen acquainted with its mode of action. He found, however, that with half an hour's instruction four of the men could work it with great satisfaction. By the machine which he (Mr. Rafferty) introduced, some years ago, he could drill and tap as quickly, perhaps more quickly; but the machine of Mr. Upward certainly had this advantage, that it effectually checked the loss of gas during the operation. Every one who reflected upon the chances of loss of life and property from this cause would be able to judge of the importance of a means of prevention, and on this ground alone he had every confidence in recommending the adoption of this apparatus. There were some defects in the original construction which he thought he might point out. One of these was in the drill apparatus. He found that his men had broken several of the teeth in using it, but no doubt Mr. Upward would be able to show that he had overcome the difficulty by an improvement in the tempering of the metal. Another thing which occurred to him to mention was, that it was not sufficiently deep to cut through thick pipes. In Manchester the pipes employed were thicker than those in ordinary use, and therefore it would be necessary to have the drill deeper. Mr. Upward would, perhaps, be able to say if this could be readily done. It would be an interesting piece of information, what amount of gas could be saved to a company by the use of the apparatus, and it would not be difficult to make an estimate on the subject. Next year, if he were able to get the apparatus into use, he might probably be in a position to state the saving in this respect upon a 1½ and a 2 inch drill.

Mr. Cathels, having had the apparatus in operation for the last twelve months, could speak with great confidence as to its advantages, although he did not go through the whole operation described in the paper. He simply with a chisel cut off the rough parts of the pipe, and then, having adjusted the flange, drilled and tapped the main. After that operation was completed, the tap was unscrewed and withdrawn by the length of the piston, which enabled the valve to be closed. A cap was then put over the elastic piece, which was pushed through the disc; the valve was then opened, and the connexion screwed into the main; but he did not use any wax and tallow wafer in the process. He thought the advantages pointed out by Mr. Jones were sufficient to bring the apparatus into general use. Without some such instrument, although managers provided drills, and insisted upon their use, they would frequently have obstinate men in their employ who would continue, in their absence, to punch holes. There was no difficulty in this apparatus; it was easily adjusted and easily worked.

Mr. Johnson (London) said he had had the apparatus in use for three years, and had laid between 3000 and 4000 services with it. He had never found an escape of gas after the service was completed—a thing which often occurred under the old system. In London it was almost impossible to get a man to use a drill at all; in fact, there was not one case in three where they could drill with the ordinary clip. There were such clusters of mains that it was impossible to get a clear space to work, and men engaged in laying large services were frequently overpowered with the escaping gas. As to the saving in this direction, he felt sure that by the use of the apparatus the leakage accounts of the companies would be materially reduced. He found his workmen were so well pleased with it that they would not

think of employing anything else, and would use every effort to get over the difficulty of applying the drill, which must be the case where the streets were crowded.

Mr. ELDRIDGE (Richmond) said there was only one question about it. The utility of the apparatus was admitted; the main point, therefore, was the cost of it.

Mr. CATHELS said he ought to have mentioned that he had seen one imperfection, which was that the tap was not sufficiently long to get entirely through the pipe. He believed, however, that Mr. Upward had now overcome this difficulty.

Mr. CROSLEY (London) said he had the gratification of meeting Mr. Upward at the Chartered Gas-Works on the previous Friday, and that gentleman was kind enough to explain the operation of the machine to him. He had had a great deal of experience in drilling iron for many years, and in the different modes adopted for the purpose, and he must confess that he never saw anything connected with the subject which gave him more sincere pleasure than witnessing the operations of Mr. Upward's men with this apparatus. The first pipe operated upon was a pipe of 5 inches diameter, which was placed at such a level that he could see the interior of it; the size of the hole drilled was 2 inches diameter. Mr. Upward asked 20 minutes to complete the operation, and the actual time occupied was only 17 minutes—viz., 8·40 minutes to drill, 0·30 to tap, 0·30 to insert the service-pipe, 2·50 loss of time in talking, 4·30 detaching apparatus. As he had stated, he could see right into the pipe; he saw the cutter come through, and certainly he never saw anything more cleanly cut. There was this advantage about it, that the thread was clean cut to the very edge. The next operation was upon a 6-inch gas-pipe, with the same sized service inserted. There were 5½ inches gasholder pressure upon the pipe, for the purpose of demonstrating that there was no leakage or escape of gas during the operation. The time occupied was as follows:—Drilling, 10 minutes; drawing the drill, 1 minute; tapping, 1 minute; preparing service, 1 minute; screwing the service in, 30 seconds; detaching drill, 1 minute; detaching apparatus, 5 minutes: total, 19 minutes 30 seconds. Although there were 5½ inches pressure of gas on the pipe, a lighted taper applied to the joint failed to produce the slightest evidence of leakage. Heat was then employed round the joint to melt the wax and tallow wafer on the inside. When that was done, the cap was taken off the end of the pipe, and a light being applied, a flame of between 5 and 6 feet in length immediately rushed up, indicating the great pressure upon the main although during the whole operation of drilling and inserting service-pipe not a trace of blue flame could be detected. To his mind these experiments were very satisfactory as to the safety and security of the apparatus. He had regarded it at first as somewhat complicated in arrangement, but before the operations he had witnessed were completed he felt that in half an hour he could manipulate the instrument himself. The next experiment he saw was the application of the apparatus to water-mains. A force-pump was attached to the main at one end, and a Bourdon's gauge at the other. A 1-inch drill was used. The time employed was as follows:—Fixing the apparatus, 3·20 minutes; drilling, 3·40; loss of time in discussing the subject, 1·30; tapping, 1·30; drawing the tap and preparing to insert the service, 3·0; inserting service, 2·0: total, 15 minutes. The Bourdon gauge at this time represented a pressure of water equal to a head of 230 feet. During the operation there was a little leakage, but the total escape of water would have gone into a half-pint glass tumbler. It was, therefore, with very great pleasure he drew the special attention of the association to that which, in his opinion, was one of the neatest things he had ever seen, and one of the most effectual for the purpose designed. It was an invention which reflected the highest credit and honour on Mr. Upward.

The PRESIDENT said he thought they must all be fully convinced of the ready application of this apparatus to the purpose for which it was intended, and they had now before them an excellent illustration of the way in which the work was performed. He quite agreed with Mr. Crosley that the invention was one of the prettiest and best brought to bear for this purpose, and he had no doubt it would result in a very large saving of leakage, and the preservation of mains from the damage too often done to them in making connexions.

Mr. UPWARD, in reply to Mr. Cathels, said the first two or three apparatuses were deficient in this respect, that the cutter was only made to cut through a ⅜-inch pipe; since then it had been made to cut through a ½-inch pipe. With regard to the tempering of the drills, they were at first made a little too hard; since then they had been much improved in this respect.

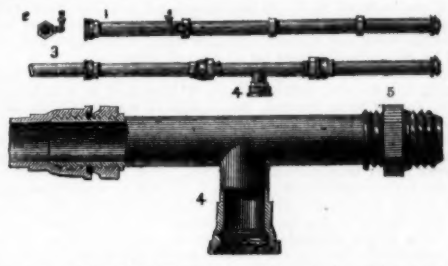
The PRESIDENT inquired whether the cutter would last long.

Mr. UPWARD said the 2-inch cutter on the table had drilled upwards of 200 holes, and was still as perfect as ever. As might be expected, the teeth occasionally broke, but even when they did it did not prevent the cutting of the hole. He had, by way of experiment, purposely broken out every tooth but one, and the hole had been as accurately cut through the main as if the whole nine had been at work. He was told by Mr. Johnson that he had some cutters which had been at work for three years and a half. But should any accident happen to them, they were easily removed and fresh cutters inserted. As to the price of the apparatus, he believed it was £20, with some discount off; but for that sum an entire set of tools was supplied for drilling and tapping service-holes from ¾ inch to 2 inches diameter. Remembering, too, that by the use of the apparatus the necessity for hammers, chisels, and gougers was entirely obviated, it would be seen that there was not much to complain of on the score of cost.

Mr. C. M. BARKER (London) read the following paper:—

ON UNLEAKABLE JOINTS FOR GAS AND WATER MAINS AND SERVICE CONNEXIONS.

The importance of sound joints for gas-mains and services is a subject which has been brought before the notice of the members of this association on various occasions; and, as mains and service-pipes have been aptly termed the "life of a gas company," on which good or bad dividends mainly depend, and as it has been proved that the loss from leakage in existing gas-works mains ranges from 10 per cent. to 33 per cent. (exclusive of the loss by condensation), and that the loss by such leakage arises principally from defective joints, whether made of lead and spunyarn or by turned and bored joints, the importance of the subject, and the necessity for an improved system of joints, become apparent, and cannot be denied. It is not only that this leakage is a loss to the various gas companies, but that it has a most prejudicial influence on the sanitary condition of our cities and large towns, and inflicts a serious injury on our social position in connexion with the extravagant and useless waste of our coal-fields, as it has been authoritatively stated that 100,000 tons of coal are yearly wasted by leakage in the gas-mains in London alone. This great loss is of sufficient importance to direct the attention of the meeting to any remedy which can be proved to satisfactorily prevent the evil, and provide joints and connexions practically unleakable, and the writer has, after many experiments, devised a plan which accomplishes the desired objects, as will be proved on investigation of the patent screw pipes now before the meeting. These patent screw pipes are now in use, and are found to make permanently sound joints with a certainty that no other pipe can surpass, whilst the hexagonal bands cast on them at various distances render service connexions secure and reliable, from the advantages of their flat surface and the convenience of making a good joint on either side of the pipe throughout the whole of its length.



These pipes can be laid with great rapidity, and require only a small quantity of cement to securely seal the joint. This cement fills the annular rings that are *in* the socket and *on* the spigot, as well as the screw, so that, when the joint is made, it is enclosed and compressed into the annular rings, and thereby unleakably closes the joint, and secures the cement from fracture or decay. The screws are cast with a lash, or play, on the thread, and this permits the pipes to lie obliquely, or in a curve, and can be thus laid by any labourer with nearly the same ease and rapidity as though he were laying them in a straight trench on a dead level. These patent screw pipes, therefore, save the expense of such expensive adjuncts as lead and spunyarn on the one hand, or of turning and boring on the other hand, as well as the additional cost of skilled labour now required in laying the pipes at present in use. The patent pipes are manufactured without any addition in weight to the ordinary pipe, and are being supplied cheaper than the turned and bored pipes, and only exceed the first price of ordinary cast pipes by a very slight amount. It is apparent, therefore, that the patent screw pipes possess advantages over ordinary pipes in—

1. The saving to gas companies by prevention of leakage;
2. In the saving of cost of pipes and the labour in laying;
3. In the rapidity with which they can be laid, and the lessened time during which roadways have to be broken up;

And, lastly, by preventing the injury to the public health, so often deleteriously affected, as well as life rendered unsafe, by the exhalations arising from gas leakage under the present systems.

In conclusion, I beg to lay before you a copy of a letter recently received from Lincoln:—"Gas-Works, Lincoln, May 27, 1869. Dear Sir,—At your request we have this morning dug down to five of the joints of your patent pipes; there is not the slightest leakage, the joints being as sound as it is possible for joints to be. I am of opinion that the pipes will give way or leak anywhere rather than at the joint.—I am, dear sir, yours faithfully,

"Mr. C. M. Barker." "W. P. THROSBY.

Mr. WARNER (South Shields) asked what mechanical arrangements the writer had for moving large pipes—say from 12 to 14 inches.

Mr. BARKER said he had nothing more than a round iron bar across the trench.

Mr. WARNER inquired whether the pipes exhibited were ordinary sand castings.

Mr. BARKER said they were, and were made by the Butterleigh Company.

Mr. FRASER said they were all aware that leakage from mains was of very great importance, and any invention tending to reduce that leakage ought to commend itself very strongly to the attention of gas managers. It occurred to him, in listening to the paper just read, that there was one objection to the mains described by Mr. Barker—viz., that there was no provision made in any way for a subsidence of the soil. It was well known that in large towns and in the case of large mains this would be a serious matter, and it seemed to him that, in such circumstances, the old lead joint would be most desirable. Such mains as had been described must necessarily give way if a subsidence occurred, because the joint was stronger than the pipe itself. The point referred to by Mr. Warner was also one of importance, and it was difficult to conceive how 2-feet pipes could be screwed up without expensive mechanical arrangements. Upon that no explanation had been given.

Mr. H. JONES said the use of screwed pipes was no novelty. Something like fifteen years ago they were introduced into France, and employed very extensively, but within the last four or five years they had given place to turned and bored joints. In the bitumenized pipes of Chameroi the joints were all originally made with screws, but there was so much trouble in fixing them, and so much uncertainty from the stripping of the thread and other causes, that they were given up entirely for turned and bored. He (Mr. Jones) had taken up a good many miles of Chameroi pipes, and, on examining the screws, had not found them much injured, but sufficiently so to allow of the escape of gas. The facility of putting a turned and bored joint together, as compared with a screw, was very great, for with large sizes it was impossible to turn the pipe round with sufficient truth to get a good joint. He was rather astonished at the remark made by Mr. Fraser as to the danger of having a rigid joint. In Liverpool all the canalization was by rigid-jointed pipes, and in London the water companies almost exclusively employed turned and bored joints.

Mr. COPLAND (Hull) said it would have been satisfactory had Mr. Barker exhibited a specimen of a curved instead of only a straight pipe. The great difficulty attending the use of turned and bored as well as screwed pipes arose from the necessity, in a system of pipe-laying, of making curves, to avoid sewers, &c. It was this necessity which had made lead joints so generally acceptable. One of the advantages claimed for the improved joints now before the meeting was the facility they afforded for being readily taken up; but, in his opinion, if such pipes were laid with Portland cement in the joints they would never be able to be taken up.

Mr. MELLOR said Chameroi's pipes had been used in Calcutta. They were first put together by screws, but, though the screws were very loose, and they were very easily put together on the surface of the ground, it was found so difficult to turn them that they were obliged to melt off the ends, and use lead joints. Although he did not approve of Chameroi's pipes in the abstract, still the question of leakage was not that of the joints; they were nearly the same in effect as cast-iron turned and bored.

Mr. WARNER said he had lately taken up a considerable number of old 2-inch pipes, with lead joints, which were eaten through entirely from having

been so long in the ground. He tested them before he took them up, and found that, with an inch pressure, the leakage on 100 yards was something like 10 feet in 9 minutes. On opening up the main, however, he found that the leakage was not from the joints—they were as good as when first laid—but through the metal itself. With regard to screwed connexions, he could not conceive why a screwed joint, left rough as it must necessarily come from the working of a foundry, should be better than a mathematical correctly jointed service. In the turned and bored joint the connexion was dependent on the metal itself; in the one referred to in the paper it depended upon the cement used in the operation. The writer of the paper had given no idea of the extra cost of these pipes, nor whether the extra cost, whatever it might be, would be the same for all sizes of pipes.

Mr. RAFFERTY said, with regard to small-sized pipes, he saw no difficulty in working the screwed joints. Pipes of from 2 up to 6 inches diameter could very readily be so treated, but in pipes of a larger size he thought it would be impossible to adopt them.

Mr. BARKER, referring to the observations made on his paper, said the objection to his pipes, that in the case of a subsidence of the soil the mains would break rather than yield at the joints, did not appear to him a serious one. Indeed, the continuous and unperceived leakage which took place from defective joints was a more serious evil than the fracture of a main, which at once gave notice of the escape it occasioned, and allowed of an instant remedy. No doubt screwed pipes were no novelty; the novelty here was the socket with the flange to it—not merely the screw, but the peculiar mode of its formation. With reference to laying such pipes on the curve, he might say that at Lincoln it was practically done, the screws being cast with a lash, facilitating the operation, and making it easy to lay pipes at any desired incline. It had been objected that these joints were dependent upon the cement employed. It could not be otherwise; a simple screw on a cast-iron pipe without cement would never answer for a joint. One of the great advantages of these pipes was the readiness with which the joints were made, and, as to the cost, it was a question of supply and demand. The method by which the pipes were made was very ingenious and rapid, and they should not be more expensive than ordinary pipes.

Mr. WARNER asked if there was any extra charge made per ton to the Lincoln Company.

Mr. BARKER said there was no charge made at all; it was done there merely as an experiment. The price of these pipes at Butterleigh was about £5 5s. to £5 7s. 6d., and they might be supplied at considerably less. They would always be willing to supply them at half the price of turned and bored joints. With regard to the application of the principle to pipes of a large diameter, he remarked that it was never intended to make these pipes beyond 12 inches. In answer to the president, he stated that the smaller sized pipes were cast horizontally; those laid at Lincoln were cast vertically.

Mr. DUNNING said if a certain amount of slack were left in the screw, there must be a little extra cement used in the joint before it was screwed up. A portion of that cement would afterwards be squeezed out, and so contract the orifice of the pipe, forming a trap for naphthaline.

Mr. BARKER replied that the superfluous cement would be on the exterior, and not in the interior of the pipe, and, therefore, could not have the injurious effect supposed.

Mr. ESSON read the following paper:—

ON A REGISTERING GAS QUALITY TEST.

The rate at which gas issues from the same orifice and under the same pressure is as its quality. On that law is the "Registering Gas Quality Test" constructed. This test has been long used in various ways. Lowe's jet test is well known. In it, *cæteris paribus*, the length of the flame is taken as the index of quality. In others the jet maintained at a uniform height, the time required for the consumption of a cubic foot per hour is taken as the index of quality. A 3-inch flame, supplied through an orifice 1-33rd of an inch in diameter, will consume 1 cubic foot of 14-candle gas in about 47minutes; of 25 candles, in about 75 minutes.

In the machine exhibited the pressure in the jet is maintained at a uniform amount, and the speed or rate of the meter in passing the gas is recorded on a circular and revolving paper index, driven by clockwork, and making one revolution in 24 hours. The rate of consumption per hour may be from 1·5 to 2·5 cubic feet per hour. The recorded consumption is represented on the circular index, not in figures, but in a species of vandyking. These diagonal and pointed lines are traced on the paper index by means of a pencil. The number of points made indicate the quality of the gas. One morning the points may number 90 points, another 120 points, and so on. The value of the points can be occasionally ascertained by means of the photometer. If the points are at a similar distance from each other, then the gas during the preceding 24 hours has been of a uniform quality. When the points are further apart than at that time, it shows the gas has been of better quality than when the points are nearer. If this machine is secured against tampering, it will daily exhibit an unerring and truthful comparative test of quality, easily converted into the usual expression for denoting the illuminating power of gas. The continuous record, produced in the manner described, is all, so far as known to the writer, novel, and is free to any one.

Mr. ESSON said the durability test described in his paper suggested itself to him on the occasion of Mr. Sugg exhibiting a very ingenious machine for registering the quality of gas by the quantity passing through a jet. It seemed to him at the time that, though that arrangement was very excellent, it was beyond the reach of the majority of gas companies. A jet-test, as was well known, was no novelty. In places where rich gas was in use it was usually the test applied, and there, instead of saying the gas was of so many candles illuminating power, it was said to be so many minutes—*i. e.*, in Scotland they adjusted the size of the flame, and estimated the time necessary with such flame to consume one cubic foot of gas. By the durability test he had just described, the comparative richness or poverty of the gas was denoted by the greater or less number of points on the circular index, and the value of those points could be readily determined by the photometer. With the apparatus he had in use at Cheltenham, 102 points indicated that the gas was of very nearly 13 candles illuminating power.

Mr. ANDERSON inquired whether Mr. Esson had compared the points with the height of the flame.

Mr. ESSON said he did not regard the height of the flame at all. What he desired to provide was a continuous record on paper during the 24 hours, and he could not get the height of the flame to work the pencil.

Mr. ANDERSON said the object of his question was rather to ascertain, as a matter of fact, whether the height of the flame had been compared with the points, so as to determine if the flame rose or fell in proportion as there were more or less points recorded on the revolving index. If so, they might also depend upon the height of the flame as a test.

Mr. ESSON said no doubt he had observed it, but he had not recorded it here in any way, because he felt that the greater the simplicity the better. At first he designed it simply as a check for the men, that they might know whether they were doing right or wrong.

Mr. ANDERSON agreed that the simpler the arrangement the better, but then it appeared to him that to measure the height of the flame by the eye, looking across the index, was a simpler matter than looking at the points. A very close approximation might be made of the illuminating power by noticing the height of the flame. A 7-inch jet, at 5/10ths or 6/10ths pressure, gave in London an illuminating power equal to 14 candles by the photometer, and if, through all the variations of illuminating power, the height of the flame correspondingly varied, a very easy mode would be obtained of arriving at a satisfactory conclusion, and one which might be adopted where time and opportunity did not serve for photometric observations.

The PRESIDENT concurred with Mr. Anderson in regarding the jet photometer as, perhaps, one of the best guides which the workmen on the premises could possibly have, and he thought that a jet photometer with a duration test was a more reliable standard than anything yet contrived. He would sooner trust to it than to the candle standard. He had repeatedly found that the jet indicated the state of the photometer a mile off from the town with the utmost exactness.

Mr. DUNNING said there was one thing exceedingly valuable in this arrangement to managers—viz., that it faithfully registered, during their absence from the works, the quality of the gas made during the whole 24 hours. The test of the length of the flame was an excellent guide for the men, but this arrangement gave to managers an unerring check upon the whole working. By this they could tell when the gas was of less value than it ought to be, because, if weak in quality, the arm travelled so much more rapidly.

Mr. ANDERSON remarked that it would give them an unfailing indication when the night men missed a charge.

Mr. ROMANS also thought the instrument was one of great value to managers. In Dublin, where the gas was tested by day as well as by night, he had found the greatest difficulty in keeping it up to the standard of 17 candles, and he instituted, along with the photometer, a book in which the man in the meter-room registered the height of the flame every hour during the 24 hours. But then he necessarily had to depend upon this man doing his duty faithfully. This little instrument performed the duty mechanically, and left a faithful record for inspection at any time. As a matter of fact, he might state that unless the jet photometer, with 6/10ths pressure, gave a flame of 9 or 10 inches, he could not get 17-candle gas. It appeared to him that Mr. Esson's quality test supplied the very thing he had been long looking for.

Mr. NEWBIGGING expressed the gratification he felt in seeing this beautiful invention. It appeared to him that by the use of this instrument they would be able to dispense with boards of chemical referees as far as illuminating power was concerned. Here they had a permanent register not dependent at all upon the manipulation of figures; there was no necessity for entries in books, and there was no easy mode of tampering with the results indicated. This was a something tangible which the public could depend upon as correct. Lowe's jet photometer answered this purpose so far as it gave the managers of gas-works information at the moment of examination, but here was a permanent record to which he could refer at any time for his own satisfaction, and to meet any complaints as to quality at any given period.

Mr. SUGG, as a manufacturer, did not like to find fault with an instrument of this kind, but he might be allowed to say that he and Mr. Kirkham had tried the duration test and jet photometer perhaps more than any one else, and the table exhibited in the room, showing the results of experiments for ascertaining the relation between the indications of the jet photometer and those of the French and English standards for determining the illuminating power of gas, was laid before the Institution of Civil Engineers, and the whole system fully explained. That system had been tested by something like 1200 or 1300 experiments, made with average candles, so as to get at the facts of the case. Working with a 7-inch flame, it was found that the lower the pressure the higher was the quality of the gas. At a pressure of ·63 of an inch, and with a 7-inch flame, a number of experiments proved that the gas had an illuminating power of 14 candles, the duration test showing that 3 minutes 59 seconds were required to consume one-tenth of a foot of gas. If it took less time than that, the gas was of a lower quality than 14 candles; if it took more, it was higher. So delicate was this test that it became important to register the time of consumption to a second. He was afraid the instrument exhibited by Mr. Esson did not register it with anything like that precision. By the table exhibited it would be seen that 11-candle gas required 40 seconds, burning at the rate of 2 feet per hour; and 21-candle gas required 4 minutes 24 seconds. The question of time was therefore a very important element in the consideration of the subject. With the two instruments together he had no hesitation in saying that the illuminating power of gas could be ascertained to within half a candle exactly.

Mr. ESSON said he quite appreciated the whole of Mr. Anderson's observations, and he wished it to be distinctly understood that he had not yet verified these results. They were not complete, nor anything like complete, and he did not like to venture any statements until they were verified. Replying to Mr. Sugg, he might say he never attempted to make this a perfectly exact instrument, and merely intended it to be a record of what was going on at the works during the absence of the manager. There was no doubt that what Mr. Sugg had said was very much to point.

On the motion of Mr. ANDREWS, Mr. Rafferty and Mr. Warner were appointed scrutineers of the votes in the election of officers of the association for the ensuing year.

Mr. R. H. JONES (Dover) read the following paper:—

ON NUISANCES ARISING FROM THE MANUFACTURE OF GAS.

In venturing to direct the attention of the members of the British Association of Gas Managers to this question, I do so hoping that some discussion will follow which will lead to the consideration of the best means to reduce to a minimum the causes of those complaints which are so frequently made by persons resident in the vicinity of gas-works.

I glean from the perusal of some decisions in courts of law, that the term "nuisance" is applied indiscriminately to "disturbance of an easement, and infringement of the natural rights of property."

Some ancient authorities appear to have recognized a sort of right to corrupt the air or disturb the natural easement, provided that at the commencement of it no one was in a situation to be injured by such corruption or disturbance; the party afterwards complaining was said *to have come to the nuisance*, and was supposed to have no right of action. This doctrine is a very popular one, but is at variance with recent legal decisions. There is a case (6 Scott, 500, 4 N. C., 183) where an action was brought for a nuisance occasioned by the business of a candle-maker, who pleaded three years possession of his premises prior to the complainant becoming possessed of his

house, and that during all that time he had carried on his business there in the same manner and degree, and to the same extent and at the same hours as at the time when the nuisance complained of took place. Chief Justice Tyndall remarked that the defendant (the candle-maker) was the first occupier, but the plaintiff came to his house clothed with all the rights appurtenant to it, one of which, at common law, is a right to wholesome and untainted air, unless the business which creates the nuisance has been carried on there for a great length of time, then the law will presume a grant from his neighbour in favour of the party who causes it. Justice Parke observed that "20 years user would legalize the nuisance, but that in the case before the court the defendant only alleges a user of three years." Another learned judge on the bench concurred in the verdict against the defendant, and said, "An offensive trade may be a nuisance or not, according to the place in which it is carried on; here the manufactory complained of is not shown to have been remote from human habitations, and there is nothing on the face of the plea to show that the nuisance is hallowed by prescription;" and Mr. Justice Bosanquet added, "It is clearly not enough, in such a case as this, for the defendant to show a short possession. Nothing short of 20 years user will afford a defence."

I have quoted the judges remarks pretty fully in order to show what the law considers a nuisance, and although 20 years user seems to legalize a nuisance, it is questionable whether even that user is available by gas companies, because there is not a gas-work which has not during 20 years very considerably increased its business, and any nuisance existing at the present time must be of greater relative extent now than it was 20 years ago.

I have, unfortunately, had some experience in defending legal proceedings promoted by local authorities on the grounds of alleged nuisances committed at gas-works.

At Canterbury, some four years, my partner and I undertook the reconstruction of the gas-works there, and subsequently contracted to make the gas for two years. We substituted oxide of iron for lime, and put up apparatus for the manufacture of sulphate of ammonia. Being strangers and pilgrims in that ancient city, the righteous indignation of the citizens was aroused against us, and it was said we had introduced novelties in the gas-works which were a nuisance. It is scarcely credible, but it is a fact, that a man, living in the house adjoining the works, led the directors to believe that we were spoiling his wife's trade as a laundress by using oxide of iron for purification, which it was asserted was causing the linen to be spotted with iron-moulds! The manufacture of sulphate of ammonia was also said to be an intolerable nuisance, creating peculiar smells every morning when the citizens took their constitutional after breakfast. We were summoned, under the Nuisances Removal Act, for creating noxious effluvia from the manufacture of gas; and when before the magistrates I took advantage of the 28th section of the Act, and claimed the removal of the case to a superior court. However, no further steps were taken, and the matter dropped. The gas company shortly afterwards re-entered as manufacturers of their own gas, and although they have continued to use oxide and to make sulphate, the local authorities have thought fit to abandon any further interference with the gas-works.

At Waterford, a few months ago (where my partner and I manage the gas supply), a complaint was made against us that we were creating a nuisance by running liquor into a stream which forms the boundary on one side of the gas-works. There was a 2-inch pipe leading through the boundary wall into the stream, which had been originally fixed for pumping water from the stream into the gasholder-tank. The inspector of nuisances laid a complaint against us that this pipe was in existence for running off our ammoniacal liquor. We proved that this pipe was disconnected and lying dead, and got a bottle of clear water from the stream, and took it into court. Had we not happened to have been in Waterford just then, we should no doubt have been innocently fined.

At Dover, however, we have not been so fortunate. About four years ago our company erected new works in a valley, some 200 yards off the main road. The wife of a neighbouring brewer took up the cudgels against us, and induced the Local Board of Health to sympathize with her. Just at that time a well-known gentleman stepped into the civic chair, and, for the purpose of acquiring popularity, succeeded in getting the local board to indict the gas company at the quarter sessions. The whole question of the management of the works we offered to refer to well-known qualified engineers and chemists, but nothing short of persecution would satisfy his worship. The indictment was carried to the Court of Queen's Bench, then sent to the County Assizes, at Maidstone, where an army of witnesses were subpœnaed, and kept in waiting for three days, and on the morning when the case was about to be tried by the Lord Chief Justice, the mayor induced our counsel to consent to a reference, it being privately understood that the case would drop; but the lawyers were not content without the reference being fully gone into. Counsel were again engaged, and witnesses in attendance. Another adjournment, and again the reference was gone into, when the arbitrator found that at times, during the year 1867, the gas-works were not conducted in a manner reasonably calculated to avoid a nuisance, and awarded the prosecutors the sum of £50 towards the costs of the prosecution, but inflicted no fine or penalty. The evidence which was proved against us was chiefly directed to one particular morning in the month of November, 1867, when we were changing a lime purifier, and, through the indiscretion of the carter employed by us, a quantity of the foul lime was, at an early hour on that morning, carted through the town smoking hot. I may mention that the local board had to pay £70 for taking up the award to get the £50.

Nuisances arising from gas-works may be said to be threefold—noise, smoke, and smell. In some gas-works the neighbourhood experiences annoyance (particularly at night) from the carelessness of the stokers taking off the retort-lids without first applying a light to the mouthpiece, and then throwing down the screw and cotter on the floor of the retort-house. By having the lids hinged to the mouthpiece this nuisance is avoided, and a saving of wear and tear effected.

Nuisance from smoke is not very general, except where tar is used as fuel, when it is difficult to avoid smoke, except with a properly constructed furnace, under the care of an experienced stoker.

As the great cause of nuisance arises from the purification of gas, I venture to suggest that the members of this association narrate and discuss their different modes of purification, and their experience in connexion with complaints of nuisance alleged to arise from the works under their control, so that we may glean the best *modus operandi* for carrying on our business so as to cause as little annoyance as we can to our neighbours.

Mr. Broadhead agreed with the writer as to the difficulties of gas managers in the conduct of their works, and referred to his own experience at Great Grimsby.

Mr. Craven said at Dewsbury the nuisance formerly complained of had been much mitigated since the partial introduction of oxide of iron in the process of purification.

Mr. H. Jones said there was one point not touched upon in the paper—viz., the fouling of wells in the neighbourhood of gas-works—which was a serious and difficult matter to deal with. Through the increased attention now paid to the management of gas-works, this evil was less frequent than formerly; but where tar and waste lime were spread about the premises, it was not possible with some soils to avoid impregnation. He urged strongly upon managers the importance of getting all refuse off the works as quickly as possible at any cost.

Mr. Simpson said at one time there was an apprehension at Rugby that the gas companies would be involved in law proceedings through the fouling of a well a mile from the works. The evil was thought to originate in leakage on the mains, but on inquiry it was found to arise from a deposit of gas tar and ashes in the yard of an adjoining occupier.

Mr. Dunning (Middlesborough) thought he might, perhaps, be allowed to speak on both sides of the question, as, fortunately or unfortunately, he happened to hold the position not only of gas manager, but also of town surveyor. There was no doubt that managers were often exposed to complaints of nuisance, but they might protect themselves under one clause of the Nuisances Removal Act, which provided that no action would lie against them if they carried on their business according to the best known mode. At Middlesborough the night soil was carried into the gas-works, and loaded away from there, and yet there was no nuisance to adjoining houses. This had been prevented by the erection of a large building, which was ventilated into a stack by a 12-inch pipe, so that all the stench was conveyed away with the smoke. The foul lime from the purifiers was also taken to this shed, and mixed up with manure. The only time he was ever apprehensive of nuisance was when the purifiers were changed. By taking care that the lids of the purifiers were lifted very gently at first, so that the whole strength of the ammonia did not come off at once, the effluvium was dissipated so gradually that no difficulty was practically felt in the matter.

Mr. Miles (Tyldesley) said, by undertaking the manufacture of sulphate of ammonia from the ammoniacal liquor produced on his works, he had been able to remedy the evil formerly complained of—the discharge of this refuse into the river.

Mr. Wood (Bury) said there were very seldom any complaints of nuisance when the gas-works were in the hands of corporations and local boards, whereas there were always plenty of persons ready to grumble when the works belonged to private individuals or companies. The best remedy in the latter case was to get two or three influential persons living near the works on the direction, and to pay a good dividend.

Mr. Anderson (Bath) described the processes in use at the works under his management.

Mr. Dunning defended local authorities generally from a desire to persecute gas companies in the conduct of their business, and said that in his town the good management of the works was as jealously looked after as it would be if the corporation had no property in them. With reference to the nuisance of noise spoken of in taking off the retort-lids, he had adopted the practice of fining every man 6d. who was guilty of such carelessness.

Mr. Paterson said he quite concurred in the observations made by Mr. Dunning, and thought it was wise on the part of managers to use every effort in their power to avoid any possible ground of complaint. So far as his own experience of local boards was concerned, he was bound to say it was not unfavourable; he had never known a groundless complaint raised by them, and he was quite sure that managers would be more likely to be successful in their operations, and secure the goodwill of the inhabitants generally, by exercising the greatest care and skill in the various departments of their manufacture.

Mr. Jones, in reply, said he was sure that every manager was desirous to do the best in his power to prevent nuisance. As to Mr. Dunning's remark that if the best known mode of conducting the business was adopted no action would lie against a company, he could only say that this had not shielded him in a court of law. For himself, he had always found the best means to prevent complaints of nuisance was to get elected a member of the local board.

Mr. W. Sugg read the following paper:—

ON GAS-BURNERS.

Since the first introduction of gas lighting, much talent has been brought to bear upon all the apparatus and systems employed in its production, and the result has been so successful that the supply of this now indispensable article, in enormous quantities and excellent quality, at a cost which would astonish the original manufacturers, is now an affair of comparative ease. Since the formation of this association, the attention of its members has been seriously devoted to still further improve the means of producing and distributing, and I am persuaded that much good has resulted from the searching discussions which have followed the reading of the various papers. The highest chemical and theoretical science relating to gas-making has been brought in aid of your practical knowledge at these meetings, and at each session the whole subject has been so well worked over that it has become a matter of difficulty to lay before you any facts with which you are not familiar.

It is not the opinion of the writer that he is fated to do so now, and yet he thinks that he shall demonstrate that the subject of gas-burners interests you in no inconsiderable manner. Great as have doubtless been the results achieved by your labours and those of your predecessors, there has always, however, been an influence at work which has gone farther than you imagine to reduce the value of your exertions, and nullify all your improvements.

You have produced gas which, perhaps, was never more suited to the requirements of consumers for all purposes, and which certainly, as regards purity and illuminating quality, was never better or higher, and for all this it is almost impossible to find a consumer in any part of England who does not believe that the illuminating power test is a vile sham, and that the gas is not nearly so high as it is declared to be. Your experience in this matter will doubtless furnish so many examples of what has been said by the "refractory" consumer, that the course most congenial to your feelings which can be adopted by the writer will be to say no more about it. The relative position of gas manager and gas consumer are unfortunately accidentally antagonistic, and if a better feeling does exist, then it is rather owing to the general urbanity and kindliness of disposition of the gas manager than to any alteration in the consumer's sentiments as regards the gas. It is the intention of the writer in this paper to give you the experience acquired during some years devoted to the study of this subject, and to lay before you some ideas of his own for your consideration, the free discussion of which by this association may, perhaps, tend to the promotion of a better understanding between the producer and consumers of gas, and so advance the interests of gas companies generally, by making artificial illu-

mination by gas a thing now to be desired by the public generally, and by giving it a fair field in the competition between its numerous rivals.

As the writer has observed on the occasion of his addressing another society, some short time since, upon the same subject, he is not the first who has drawn the attention of engineers to this subject. Many years ago it was pointed out by Clegg, in the first edition of his work, that unless some attention were paid, not only to the manufacture, but to the proper mode of consuming gas, the labours of the engineer would to a considerable extent be vain. Notwithstanding the time which has elapsed since then, the progress made in this branch of the question has not been by any means commensurate with that of others. Such a society as this is peculiarly suitable to the elimination of correct practical views upon this subject, and to the disposal of a host of erroneous notions which have for many years surrounded the question with difficulties, and prevented the discovery and adoption of true principles, which, well directed, would have placed this country still further in advance of all others in the science of artificial illumination.

To obtain from the gas produced the greatest amount of light does not involve any abstruse theories.

The vapour of carbon, in combination with hydrogen in various manners which constitute ordinary coal gas, requires but one condition to be fulfilled in order that it may evolve all the light of which it is capable—viz., just its proper chemical equivalent of oxygen; more is as destructive to the illuminating power of coal gas as to that of the oxy-hydrogen light; less gives rise to those complaints among consumers which are by far too familiar to you to need enumeration; sufficient to say that a select vocabulary of terms employed by consumers generally, in speaking of gas, comprise considerably more expressions of a condemnatory kind than would be agreeable to ears polite. One remark only the writer would make, which is, that it is his firm belief that the complaint of the smell of sulphur, produced by the combustion of gas in rooms, is solely owing to imperfect combustion, and that the quantity of irremoveable sulphur left in the gas supplied to the public is, as stated by no less an authority than the successor of Faraday, Dr. William Odling, in a paper read before the Association of Medical Officers of Health, London, not sufficient to produce disagreeable results. But the question of ventilation, important as it is, cannot be treated upon in this paper.

It will be evident, upon consideration, that the supply of an exactly sufficient quantity of oxygen demands a special arrangement of burner for every quality and quantity of gas, and that great care is necessary in the regulation of the flames so as to secure this result.

Thus an apparently insuperable difficulty rises up at once, for it may naturally be asked, how is it possible that a consumer may be induced to take all this trouble? And so a recommendation in "Clegg," to the effect that "it is better that the oxygen supplied to the burner be slightly in excess rather than otherwise," has been interpreted as largely in excess; and so the manufacture of burners suitable for the destruction of the illuminating power of the gas they consumed has been the rule, apparently in order that there might be room for a host of ingeniously contrived notions for counteracting their mischievous propensities.

Probably owing to the diversion created by the introduction of those contrivances, the simple practical solution of the difficuly has been lost sight of, and a vast amount of inventive talent misdirected; for, referring to the pages of "Clegg," it is seen that the originators of gas lighting early discovered that it was necessary to regulate the pressure of gas to a uniform rate, in order to burn it properly, and the governor was invented and protection obtained by Clegg and Crosley; and it is no small compliment to their talent to remark that they left it all as it should be, and that the efforts of a host of inventors have produced nothing better.

Thus the starting-point in the application of gas to the requirements of its consumers, is to regulate the pressure of the gas entering his premises, so that at all times it may be admitted in sufficient quantity, at a perfectly uniform pressure. This attended to, the rest is comparatively easy, for the regulation of each individual burner, at any part of the premises, can be done by the adjustment of fixed orifices, so that every one may consume a constant quantity when turned full on. The selection of the burner to be made use of depends upon the nature of the requirement and circumstances of the room, hall, shop, &c.; but nothing in this arrangement hinders the various kinds which are for selection and those which should, although they differ in form, yet give the full amount of light to be obtained from the gas.

Starting from these premises, the writer will proceed to show in what manner the burners at present in use meet these requirements, commencing with a short description of the principal burners which have been adopted since the commencement of gas lighting.

There are not many, and will be so far familiar to the members of this association as to need little comment.

The first of these is the Argand, which was made in imitation of the oil-burner called after the name of its inventor. Much thought appears to have been bestowed on the first models, and a series of experiments was made by Clegg and Grafton, in the year 1815, the results of which enabled them to fix the proper system of making Argand burners. They arrived at the conclusion that the number of holes in the top of the burner was quite immaterial, providing that each hole was in such a position that the jet of gas issuing from it could unite with its neighbour; that the quantity of air admitted to the flame must be regulated so that sufficient oxygen is at all times present to support combustion, and combine in proper chemical proportion with the hydrogen and carbon in the gas to form carbonic acid and water. They, however, say that as it may be difficult to adjust this quantity accurately, it is better that the amount of oxygen be slightly in excess, in order to avoid the liability of the escape of unconsumed carbon, and so produce smoke; and, lastly, they determined that the quantity of gas per hour to be consumed by any burner must be regulated by the diameter of the circle cutting the centre of the holes in the top. The burner they recommended as the best to meet these requirements was afterwards patented under the name of Platow's double-cone burner, of which an engraving is given in Clegg's "Treatise on Coal Gas," 1841. The diagram A is an enlargement of it. It appears, however, that some error must have been made in the engraving, because a burner made from it will not at all answer in its working to the thing laid down.

Be this as it may, no doubt exists in the mind of the writer that, constructed on these principles, burners then made must have been nearly equal to the best that can now be produced.

Notwithstanding the amount of labour bestowed by Clegg and Grafton upon the discovery of the most suitable form of burner to consume gas with the best results, yet it appears that a retrograde movement in the manufacture of burners took place some few years afterwards, for in 1841 Clegg complains bitterly of the defective form and uneconomical construction of the burners then in use, which he says are as bad as those which were in use in 1805, ten years before Clegg and Grafton carried out their experiments.

Perhaps, in a great measure, the badness of Argand burners has been greatly due to the contract system, for the aim of the seller of gas was directed to the prevention of an undue consumption, and thus those burners were most favoured which would allow the least quantity of gas to pass under heavy pressure; thus, of course, excluding all which would be likely to give a good result in illuminating power for the gas consumed as wasteful. And so, doubtless, arose that variety in the sizes of the burners, and especially in the number of holes in them, which ranged from 50 to 30, drilled very fine and wide apart, to which any one became so accustomed that long after the entire abolition of the contract system, even to the present day, they are considered by some to be the correct thing in burners.

From time to time improved burners were submitted to the notice of gas companies and the public, but the rules for their construction, as worked out by Clegg and Grafton, appear to have been entirely forgotten or set aside.

Some of the principal ones are here for your inspection, and I have prepared tables showing their photometrical value as compared with a jet of gas equal to an average standard sperm candle.

The Leslie burner appears to have been designed with a great deal of care, and with the short 4-inch chimney, which is blown into a mould so as to secure uniformity, it gives results burning 5 feet per hour of 12-candle gas equal to those obtained from the same quantity of gas burned through a 12-candle 15-hole parliamentary standard burner with a 7-inch chimney. In consequence of the breakage of the glass at the time of making these experiments, the writer is unable to say what would be the comparison between that and the Letheby burning 14-candle gas, but thinks it would be about 5 per cent. worse from its construction and the increased length of chimney which must be used for the quality of gas.

The short chimney, and probably the arrangement of the burner, is due to the suggestions of the late Mr. George Lowe.

It will be observed that instead of the brass cone outside the "combustion-chamber," as arranged by Clegg and Grafton, the chimney itself is shaped at the base so as to form a cone, and is covered over at the top, the motive being to decrease the spread of the current of heated air set in motion by the heat of the burning gas, which an 8-inch chimney, on a burner consuming 5 cubic feet per hour of common gas, is stated in Clegg to be equal to a head of water of about 3/20ths of an inch. This is probably the pressure above the flame, and the tendency of the covered-in top of the Leslie chimney would be to diminish the rush of air drawn in at the base of the outside of the flame, and thus prevent it from being oxidized.

The National burner (of which I produce a sample) is somewhat similar to the Guise burner. Like the Leslie, it has a special chimney, but with a bulb in it, and it is further provided with a button fixed over the central air-passage. These two arrangements cause the current of air to drive against the flame, and force it out into a shape somewhat resembling a tulip.

We have in both these burners, firstly, a violation of the rule laid down by Clegg and Grafton relative to the amount of air supplied to the burner, which must be in excess to so force out the flame; and, secondly, an error in the delivery of the air, for here, instead of allowing only the oxygen contained in the air to combine by natural affinity with the hydrogen and carbon in the gas, both nitrogen and oxygen are forced into the flame, and when it is considered that 79·19 parts of nitrogen are present in every 100 parts of atmospheric air, it is not surprising that these burners do not develop the illuminating power of the gas. In order to take up your time as little as possible, I beg to refer you to the tabulated statement of the results obtained by the use of the burner, merely drawing your attention to the quantity of gas required to give the same amount of light as given by the Letheby standard burner at 5 cubic feet per hour. (See experiment X X.)

The Guise burner needs no description. It will readily be seen that it has the same faults as the National burner, and experiment C C, in which 5 feet is consumed by one of these burners with a loss of 79·52 per cent., and experiment D D, in which a large size Argand of this pattern requires 10 feet per hour to equal the standard Letheby, will doubtless be considered sufficient proof of this fact.

The Bymer burner approaches near to the principles laid down by Clegg and Grafton, and is consequently better; but the writer regrets that he has lost the only one he had, and is, therefore, unable to give you its exact value as an illuminator. It is similar to the ordinary long Chambers's Argand, but both the internal and external air-passages are regulated and protected by fine perforated metal guards.

The Platow's double-cone burner, experiment K K, illustrates the decline in burner-making since the time of the Clegg and Grafton experiments. The shape of the burner is retained, but the details of its construction are wrong. The holes are not close enough, and too much air is admitted; the consequence is a loss of 50·76 per cent.

The ordinary Albert burner is one of those modifications of the original Argand, the most extensively employed. Experiments L L and R R show the value of the commoner sort, and A A that of the best. They are sufficiently well known to the members of this association to need no description.

The examples given are a few of many, and will serve to illustrate the differences which exist in the amount of light obtained by different consumers for the gas they burn. To the members of this association this table and the others will be found full of suggestions, and the writer need not trespass on your time by enlarging on this part of the subject.

The burner selected as the standard of comparison, and from which the rates of per centage are calculated, is that designed and made by the writer in 1861, used as a standard burner for testing the gas supplied to the City of London, and was adopted by Dr. Letheby after a careful consideration of the question and trials made with a number of old iron-top burners then in use. It has since been accepted as the standard for 14-candle gas throughout Great Britain and the colonies, and is even, I believe, made use of in some of the largest American cities.

Being equally suitable for, and, indeed, a great deal used by consumers, it is quite admissible for the use which is made of it in the paper.

A consideration of these differences, and some years of study and experiment, led the writer to the production of a burner which fulfils the conditions desired by Clegg and Grafton, but is directly at variance in some important points with every other authority upon the subject, and gives the highest illuminating power for the quantity of gas consumed, and is quite suitable for ordinary consumers both of common and cannel gas. Diagram A is a section of it. The communication between the combustion-chamber and the lower one, into which the gas first enters, and is regulated to the requisite flow by means of the inverted cone fixed in the crown of the chamber, is made by means of three small tubes, and in order to ensure the issue of the gas from the holes in the top of the combustion-chamber at the least possible pressure; the sum of the area of these holes is made to exceed considerably the area of the three conduit tubes. The combustion-chamber is made of steatite, and the lower parts are of hardened alloy of tin. The admission of air to the burner is regulated by means of a cone made of

bright Britannia metal, but only so as to ensure that the greatest quantity goes up the central aperture.

The gas and air moving up at the same low velocity, the oxygen in the air combines by natural affinity with the burning gas, and the nitrogen so left to go freely out of the chimney. The non-conducting property of the steatite combustion-chamber, together with the general arrangement of the supply-tubes and air-passages, ensures the delivery of the gas into that chamber with the least possible alteration in its volume. The writer was of the same opinion with Clegg and others, that heating the gas before it gets to the point of ignition was beneficial; but a few experiments tried by him upon some bat's-wing burners led to the consideration of the subject under a different aspect, and he now believes that heating the gas is equivalent to diluting it, for if a cubic foot of gas, which contains a certain quantity of carbon, is expanded into several times its proper bulk, it is evident that the carbon in it is divided over a greater area, and that to bring it into contact with sufficient air for its combustion it must be propelled through the orifices of the burner at a greater rate than if it occupied only its original bulk.

Thus the effect of heating must be more pernicious to poorer than to richer gases, although it is not conceded that any good can result even with the latter, because a better means of applying air during combustion would produce a considerably better light.

The result of the whole arrangement is that these burners will burn with equally good results gases varying in quality from 12 to 25 candles.

Burning at the rate of 5 cubic feet per hour of 14-candle gas, the small-sized London Argand gives a light about 18 per cent. better than a 14-candle Letheby burner, and is, therefore, considerably superior to the general run of burners.

Its performances with cannel gas are shown in Table No. VI., experiments X C and X E, in both cases giving the highest illuminating power for the quantity of gas consumed.

The standard bat's-wing, No. 8, which is used for testing cannel gas of 20 candles, gives—taking the mean of the flat and edge ways of the flame—18·75 candles for 5 feet per hour, while the London burner gives 20 candles for the same quantity.

The No. 8 fishtail, with an exceedingly unsteady flame, gives an average of 19·5 candles, but consumers generally could not make use of either the bat's-wing or the fishtail with a consumption of 5 feet per hour, unless in a much quieter atmosphere than that in which the Argand would be quite steady; and it is generally to be observed that it is exceedingly difficult to get a steady light from any bat's-wing or fishtail burner when they are consuming the gas with good results as regards illuminating power.

Another fact which must be borne in mind, whenever Argand burners are compared with bat's-wings or fishtails, is this, that whereas the former give an equal amount of light in every direction, the latter kinds give a greater amount of light from the flat of the flame and a lesser from the edge, and that this difference varies according to the fashion of the burner and the quality of the gas it is burning.

With a consumption of 4 feet per hour, the London Argand, experiment X E, gives 16 candles—a trifle over 50 per cent. more illuminating power than can be got out of the same quantity of gas when consumed by an average bat's-wing or fishtail, as shown by the 9 burners of that class in Table V., which it will be seen includes two particularly good burners—viz., X S, a No. 6 steatite, which is the best consumers burner for 20-candle gas, and X Q, a No. 4 fishtail on an economizer.

It seems to have been generally considered that although something might, perhaps, be done towards improving the burners for common gas, yet that for cannel gas no such thing was needed; and the whole aim of burner-makers appears to have been devoted to curing the tendency which cannel gas unfortunately has to blacken the ceilings of rooms in which it is consumed. For the prevention of smoke it has been the rule to diminish the sizes of the holes in Argands, and lengthen the chimney; and the principal, and, indeed, very often the only, difference between a cannel burner and a common one has been and is, that in the former the holes are much smaller than in the latter.

Thus it has become an axiom that, in order properly to consume cannel, it must be made to flow through the burner at a much greater velocity than common gas.

A consideration of the subject leads to the question, why should it? There is a greater amount of carbon to become consumed in the same time, and, consequently, a greater amount of oxygen is required to do it; but each particular atom or molecule of carbon will take just the same time properly to consume it as with common gas, and that if sufficient time is not allowed it will go off only partially consumed, and will not form carbonic acid and water as it should if perfect combustion took place.

Table No. V. will show the effect produced by this system. Experiments X T, X O, X V, X Y, and X Z are made with burners specially sold for cannel gas, and are called cannel burners. The quantity of gas required by them to give the same amount of light as the standard bat's-wing is sufficiently great, being 40 per cent., to make it a question whether the consumer would not be quite as well off with common 14 or 16 candle gas, if he only took the trouble to burn it to the best advantage. The average loss of light by these burners, with 5 feet of gas per hour, is 45 per cent. As a further refutation of the theory above mentioned, the writer would draw your attention to experiments X A B and X B B, which are made with burners sold for common gas. They did not show any very good results with 14-candle, and they were accordingly supplied with 20-candle gas, for which they are evidently better suited. Of course, the large one, X A B, is not made to burn so small a quantity as 5 feet per hour, and the small amount of light given for that quantity must be considered against it.

Loss at	5	feet	62·5 per cent.
,,	7·8	,, ...	35·85 ,,
,,	8·8	,, ...	5·80 ,,

which is its maximum light. A trial made with a burner of the same fashion and size, but with fine holes, made for cannel gas, obtained from the Houses of Parliament, where it was left as a specimen several years ago, did not give such satisfactory results, for, with nearly 8 feet of 21-candle gas, it gave the same amount of light as was emitted by a small London burner burning 5 feet of 14-candle gas.

Platow's double-cone burner (experiment X Z) owes the tolerably good result achieved by it, without doubt, to the fact of its being *worn out*, for it was given to the writer by one of the oldest gas-fitters in the trade, with the remark that it was of no use except for old metal, and was picked out of a heap of old burners condemned as worn out.

From these and other facts the writer forms his opinion that the same system pursued with Argand cannel as with common burners will prove beneficial, and that the issue of this gas at the lowest possible pressure, and regulation of the size of the burner to the quantity of gas required to be consumed by it, will well ensure the combination with it, by natural affinity alone, of sufficient oxygen to consume it with the best possible effect.

In calculating the per centages of loss of light, the standard gas has been considered as 20 candles, for although the standard bat's-wing shows it to be 21 candles, yet the highest illuminating power from the combustion of 5 cubic feet of gas was obtained by the use of the large size London burner, which gave 20 candles in all directions, while the mean of the light limited from the flat and edge of the standard flame is only 18·73 candles. For those burners which consume more or less than 5 cubic feet, it has been assumed that the amount of light per foot consumed increases in simple proportion. This plan, of course, in all probability favours those burners consuming more than 5 feet per hour; and for those consuming 4 feet, the small London burner, X E, which gives 16 candles, has been taken as the point of comparison for that quantity.

It will be observed that in this case it is in direct proportion with the light obtained from 5 cubic feet.

The next class of burner in order of merit to the Argand is the bat's-wing. Except for public lighting and outdoor work, these burners are not very generally employed, although they are far more deserving of notice than the fishtail, which is largely preferred to them, especially among consumers.

The reasons for the writer's preference for bat's-wings are simply these: Firstly, it can be made to consume either 14 or 20 candle gas with as small a loss of light as the fishtail, and with a steadier flame, without the assistance of economizers or perfecters. Secondly, when burning with its maximum effect, an increase of pressure will not cause it to roar or destroy the shape of its flame. There is a third reason, which has only lately existed, and therefore does not affect the question as regards those now in use. It is this: that it is now possible to make a bat's-wing burner which will give a flame of the same shape, having all the characteristics of a fishtail without its musical tendencies, and which will better develop the illuminating power of the gas it consumes. With gas of lower illuminating power than 14 candles, the steatite bat's-wing of the ordinary form gives a better result than the best made fishtail for the same quantity of gas.

Referring to the table of bat's-wings, C Z and A Z are examples of bat's-wings which develop most the illuminating power of 14-candle gas—in the case of the first, with a loss of only 7·4 per cent., and in the second, with a loss of 8·58 per cent. A Z, however, with 12-candle gas, is better than C Z.

This burner was made by the writer specially for the public lighting of the city of Amsterdam, and has since been considerably employed in various parts of Germany.

Burning 6 feet per hour at 2/10ths pressure at the point of ignition of 12-candle gas, it gives within about 5 per cent. of the light given by the Bengel burner of Paris, which is rather better than the 15-hole standard burner for 12-candle gas.

It is a noticeable fact that a bat's-wing burner, burning at a pressure of 2/10ths of an inch at the point of ignition, will, with 12-candle gas, give a much steadier flame than the same burner burning under the same pressure with 14-candle gas; and so the difficulty goes on increasing with every increase of illuminating power. This may in a measure be remedied by putting a small piece of wool very carefully into the cone into which the burner is screwed, which will equalize the flow of the gas, and prevent the strongest part of the current rushing to the centre of the burner, for to this cause is attributable, in a great measure, the general unsteadiness of bat's-wing and fishtail flames burning at low pressure. It will readily be perceived, by reference to Table No. IV., experiment A Y, that this must be carefully done, because the pressure at the point of ignition is only increased from ·26 (see experiment A Z, in Table No. II.) to ·44 of an inch.

The effect of this wool arrangement is an increase of 1 candle, and thus the Amsterdam burner is made to give with the flat of the flame the same amount of light as the Letheby Argand burner. The increase of light for a larger quantity of gas consumed by the same burner is very nearly in direct proportion—6 feet giving 16·6 candles (a loss of 1·19 per cent.), 7 feet giving 21·6 candles, and 8 feet 23·5 candles; both the latter rates show an increase of light per foot of gas consumed.

The Bronner burner gives the next best light for 5 feet of gas—viz., 12 candles, being a loss of 14·28 per cent. The cause will readily be seen by an examination of the diagram showing the principle of the Bronner burner, and the experiment A W, Table No. IV., which shows that the pressure at the point of ignition required to force the quantity of gas through the burner is 1·07 of an inch.

Experiments G Z, F Z, and E Z are put in to show the decrease of illuminating power as the pressure at the point of ignition is increased. G Z is the number of burner which is most suited to the use of consumers in rooms where there is any draught. Experiment E Z was made with an ordinary street-lamp burner, such as were in general use in towns subject to much alteration of pressure, before the introduction by the writer of the steatite lamp burner fixed on the lamp governor, and which gives the same amount of light for 5 cubic feet as the No. 6 common, G Z.

The low illuminating power given by this burner for 5 cubic feet of gas—5·41 candles, being a loss of 60·16 per cent.—accounts for the general dissatisfaction of the public with regard to public lights wherever such burners are in use; while, at the same time, it is beyond doubt that they are alike unsatisfactory to the seller of gas, because, generally unaware of their destructive propensities, he is deceived by the appearance of the flame into the belief that they are only consuming the agreed quantity of gas, when really they may be from 30 to 50 per cent. over it, and thus the not generally remunerative figure at which these lights are supplied is made still more unremunerative.

And, further, it must be observed that with this class of burners a considerably increased supply of gas is of no avail in increasing the illuminating power, for, already pressured too highly, any further increase only tends to greater waste. As an example, the writer tested such a burner taken from the lamps belonging to one of the largest London gas companies, and, commencing with 5 feet, it gave for that quantity a light equal to 7 sperm candles, with 14-candle gas; increasing the quantity, at 8 feet it reached the power of 11 candles; after which, with a continued increase, it decreased in light; finally, with 12 feet per hour, giving as nearly as could be estimated—the flame being too unsteady for accurate reading—from 5 to 6 candles.

A reference to the pressure required at the point of ignition to make this burner consume 5 feet per hour will convince you that this is a very fair sample of the sort of thing which must be employed in undulating districts where there are no regulators.

In tolerably level districts it is possible to use a burner requiring a little less pressure; but, in any case, the amount of light given for 5 feet rarely exceeds 8 candles with 14-candle gas, with 12-candle gas it may be fairly stated at 6½ to 7 candles.

Referring to Table No. 5, it will be seen that for cannel gas the generality of burners used by consumers do not, by a very long way, attain to the illuminating power of the standard burner.

Experiment X S shows the No. 6 bat's-wing to be the best for the consumer, burning fairly and steadily with a loss of not more than 7·5 per cent.

for 4 feet, and 10 per cent. for 5 feet. Experiment X R indicates, however, that a bat's-wing made to burn with a fishtail flame is the nearest approach to the Argand. Both of the flames here given are, of course, more sensitive than the Argand, but they are steadier than the No. 8 standard bat's-wing.

Upon the subject of the fishtail burner the writer will say but little. The pages of the JOURNAL OF GAS LIGHTING have doubtless made known to you his opinion. He, therefore, need only point out to you the Tables No. III. and No. V., in which their value as illuminators is sufficiently shown, both for cannel and common gas; and, reiterating his firm opinion that, for the general purposes of lighting with common gas, excepting by sun burners, the fishtail is a costly mistake, he would add that, upon trial with cannel gas up to 20 candles, he sees no reason for making any reservation in their favour, even when supplied with this gas.

In conclusion, the consideration of the subject in all its bearings will demonstrate that, whether for common or cannel gases, the best result in light and general comfort is to be obtained by the use of Argand burners, and that when these cannot, for certain reasons, be employed, the bat's-wing will most advantageously replace it, while for the fishtail, except as before stated for sun burners, there is no necessity.

But whether the one or the other be made use of, the first point to be secured and maintained is uniformity of pressure after the passage of the gas through the meter. This done, nothing prevents the facile solution of the whole question, and attainment of the most satisfactory results in every way for both buyer and seller of gas.

TABLE *of the Amount of Light, in Standard Sperm Candles, given by different Burners (such as are in use by Consumers in London and the Provinces) burning Gas which, tested by the Letheby Standard Burner, was equal to* 14 *Candles.*

No. I.—ARGAND BURNERS.

Experiment.		Rate of Consumption per Hour.	Pressure at Point of Ignition.	Illuminating Power in Candles.	Per Centage of Loss of Light.
L L	Shadowless Argand, 7-in chimney	5·0	·32	8·80	37·16
	Same burner „	6·3	·47	14·0	15·80
A A	Shadowless Argand, patent, with gauzes	5·0	·318	12·20	12·86
R R	Albert, iron top, 8-in. chimney	5·0	·23	8·10	42·19
	Same burner	6·3	·33	14·0	15·80
S S	Short Argand, 5-in. chimney	5·0	·11	9·0	35·70
C C	Small Albert, with button and glass cone	5·0	·18	3·0	79·52
F F	15-hole iron top Argand	5·0	·28	5·90	58·14
K K	Platow's double cone	5·0	·11	6·90	50·76
B B	Large Albert, with button and glass cone	5·0	·19	5·0	64·51
	Same burner	7·5	·35	14·0	33·3
D D	Large burner, with button and outside cone	5·0	·11	1·0	93·45
	Same burner	10·0	·30	14·30	49·02
G G	24-hole iron top, 7-in. chimney	5·0	·36	8·94	36·23
	Same burner 8-in. „	5·0	·36	7·90	41·9
	Same burner 10-in. „	5·0	·36	7·20	43·9

No. II.—BAT'S-WING BURNERS.

C Z	Bat's-wing, steatite	5·0	·25	13·0	7·14
A Z	„ Amsterdam	5·0	·26	12·79	8·58
G Z	„ No. 6, common	5·0	·38	12·04	14·0
F Z	„ No. 3, „	5·0	·65	8·0	42·9
E Z	„ No. 4, „	5·0	·72	9·0	35·70
H Z	„ No. 5, iron (ordinary street-lamp burner)	5·0	1·15	5·41	60·16

No. III.—FISHTAIL BURNERS.

O	Fishtail, No. 3, iron	5·0	1·12	5·50	60·97
G	„ No. 3, „	5·0	1·20	4·53	68·5
M	„ No. 3, „	5·0	1·125	6·92	50·76
Q	„ No. 4, „	5·0	1·20	5·97	58·10
F	„ No. 4, „	5·0	·69	9·36	33·14
E	„ No. 4, „	5·0	·57	9·0	35·7
D	„ No. 4, „	5·0	·90	6·13	56·17
A	„ No. 4, „	5·0	·52	11·10	20·74
B	„ No. 4. „	5·0	1·0	5·41	60·16
C	„ No. 4, „	5·0	1·0	5·50	60·97
H	„ No. 5, adamas	5·0	·66	9·0	35·70
K	„ No. 5, iron	5·0	·80	7·0	43·66
J	„ No. 5, „	5·0	·80	6·90	50·76
L	„ No. 6, „	5·0	·55	10·50	25·0
N	„ No mark	5·0	·605	10·0	31·43
P	„ No. 2, iron	5·0	1·65	3·97	71·90
R	„ No. 8, steatite	5·0	·40	12·0	14·28

No. IV.—FISHTAIL AND BAT'S-WING BURNERS, FIXED IN PATENT ECONOMIZERS.

A Y	Amsterdam steatite, with wool in the cone	5·0	·44	14·0	0·0
	Same burner	6·0	·53	16·6	1·19
	Same burner	7·0	·67	21·6	1·19
	Same burner	8·0	·76	23·5	1·19
A O	No. 8 fishtail steatite, with wool in the cone	5·0	·23	13·6	2·86
A L	Patent economizer, Neal	5·0	·82	9·3	33·66
A D	„ „ Hulett	5·0	1·19	12·0	14·28
	Same burner	6·0	1·55	13·0	7·14
A S	Patent economizer, Evered	5·0	1·18	5·6	60·24
A Q	Different pattern of do.	5·0	1·5	5·0	64·51
A R	Milan economizer, bat's-wing	5·0	·72	9·4	32·89
A W	Bronner burner, bat's-wing	5·0	1·07	12·0	14·28
A M	Hart's patent economizer, fishtail	5·0	·85	9·60	31·44

No. V.

X A	No. 8 bat's-wing standard for cannel gas	5·0	·26	20·50	0·0
	Same burner	5·0	·26	17·0	15·0
X B	No. 8 fishtail steatite	5·0	·27	21·0	0·0
	Same burner	5·0	·27	18·0	14·28
X F	No. 3 bat's-wing steatite	4·0	1·0	11·0	31·25
	Same burner, flat flame	5·0	1·5	12·4	38·0
	Same burner, edge of flame	5·0	1·5	11·0	45·0
X H	No. 3 fishtail iron	4·0	·77	11·6	25·25
	Same burner	5·0	1·17	14·0	30·0
X I	No. 4 fishtail steatite	4·0	·83	11·0	31·25
	Same burner, edge	5·0	1·24	11·5	42·5
	Same burner, flat	5·0	1·24	14·0	30·0
X L	No. 3 plug bat's-wing iron	4·0	1·20	6·0	62·50
	Same burner	5·0	1·65	7·2	64·0
X M	No. 4 old pattern bat's-wing	4·0	1·40	7·2	55·0
X N	No. 5 iron bat's-wing	4·0	·40	11·5	28·12
	Same burner	5·0	·75	14·0	30·0
X O	Iron fishtail, large, for common gas	5·0	·60	18·0	10·0
X P	No. 3 iron bat's-wing	4·0	·77	10·2	36·25
	Same burner	5·0	1·11	12·0	40·0
X Q	No. 4 fishtail on economizer	4·0	·71	13·0	19·35
	Same burner	5·0	1·4	14·4	28·0
X S	No. 6 steatite bat's-wing	4·0	·50	14·8	7·5
	Same burner	5·0	·67	18·0	10·0
X R	No. 4 new bat's-wing with fishtail flame	3·0	·26	11·8	1·6
	Same burner	5·0	·50	21·0	0·0

No. VI.

X C	London Argand, large size	5·0	·0	20·0	0·0
X E	London Argand, small size	4·0	·0	16·0	0·0
X T	Large Guise burner	5·0	·16	5·3	73·5
	Same burner	9·0	·43	20·50	42·3
X U	Small Guise burner	5·0	·30	9·4	53·0
	Same burner	6·3	·47	20·50	18·0
X Y	Albert, with cone, and no button	5·0	·67	6·4	68·0
	Same burner	8·0	1·36	20·50	35·88
X W	Leslie burner (cannel, special chimney)	5·0	·19	13·4	33·0
	Same burner	6·1	·24	20·50	14·59
X Y	15-hole burner, iron	5·0	·22	16·50	17·5
	Same burner	5·9	·27	20·0	16·68
X Z	Platow's double cone	5·0	·19	17·50	12·5
	Same burner	5·6	·22	20·50	19·81
X A B	Large patent burner	5·0	·07	7·8	62·5
	Same burner	7·8	·14	20·50	35·85
	Same burner	8·8	·18	34·0	5·80
X B B	Universal burner	5·0	·4	14·0	30·3
	Same burner	6·0	·6	20·50	14·59

Mr. H. JONES said he thought the Milan economizer was not at all a bad burner for public lights.

Mr. ANDERSON admired the construction of the London burner, the advantage of which appeared to be that it had a chamber, immediately under the point of combustion, so large as to allow of the gas passing easily at a low pressure. For many years he had been of opinion that, in order to improve the burner, it was best to have two taps, one a good way off, the one nearest the burner being turned fully on, and the regulation effected by the further one. There was one thing he would like to see proved by experiment, and that was the condemnation of the heating of gas. Many persons thought it better to do so, and Mr. Sugg's paper did not go far enough to convince him that they were wrong. He could imagine the result obtained by Mr. Sugg might arise from his taking gas of a certain temperature, and then expanding it by diluting beyond what the quality of the gas would sustain. But supposing he had had a larger burner or larger holes, and allowed the quantity of gas to go through equal in both cases, the question was whether he would not have had as much light from the warm gas as the cold. The Bronner burner referred to was a very simple thing, and he had used it a good deal for public lighting. He employed a small burner for the lower one, according to the district to be lighted, and, by experiment in the laboratory, selected a burner which would give the quantity contracted for at the regulated pressure and no more. He then took a piece of brass tube, 1¼ inch long, tapped at both ends, and screwed it on to the burner, and then put on a fine large bat's-wing. By this arrangement he found that he could increase the illuminating power of the gas from 20 to 50 per cent.

Mr. SUGG, in reply, said that with relation to the Milan economizer he simply tried it with 5 feet of gas, and the light it gave showed a loss of 32 per cent. If the quantity had been raised to 6 feet, the loss would not have been so great, and if raised to 7 feet the loss would still further be diminished. Probably at 7 feet it would not be more than 14 per cent. Mr. Anderson wished to know whether it was a fact that heating the gas diminished its illuminating power. The way in which he (Mr. Sugg) was brought to look upon the view he now entertained was simply this: he was trying some experiments with a governor to see the effect produced by cold, and for that purpose commenced the experiment at the ordinary temperature of the atmosphere, burning at the rate of 5 feet per hour. There was a vessel placed on the governor, by which he could lower the temperature to freezing-point—which he did. He expected there would be a loss of illuminating power when the temperature was so far reduced; but in the result he found that it was maintained nearly at the same rate. At freezing-point, and when hardly 4 feet of gas, as measured by the meter, was passing through the governor, the illuminating power had only been reduced by one candle. This led him to consider the question in another point of view—viz., whether if the gas was warmed as it issued from the burner, seeing that the bulk of the carbon could not be increased, except in a larger space, if the consumption were maintained at the same rate, the velocity with which it passed through would not be much higher. These experiments led to the construction of the London burner, in which the gas was consumed without any pressure, and without being heated at all.

The SECRETARY read the following paper:—

ON SELF-SEALING RETORT-LIDS.

By Mr. A. MORTON.

Anything which will effect a saving in the management of a gas-work must commend itself to the notice of a meeting like this, more especially if, at the same time, it adds to its comfort by the removal of a nuisance from the premises. The contrivance which I have the honour to submit to you accomplishes both. Its object is the sealing of retort-mouthpieces without the intervention of luting, and this has been most successfully attained.

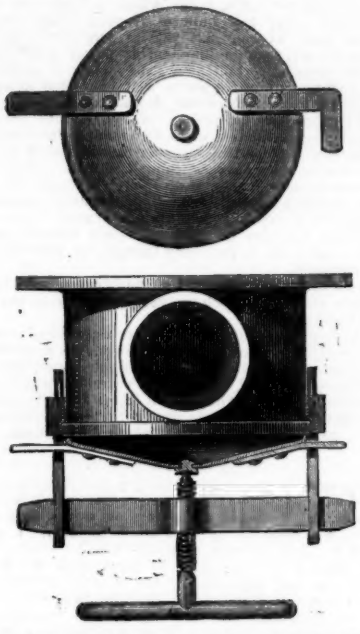
It is estimated, from very reliable data, that the present system of luting costs, in many works, from 15s. to 35s. per mouthpiece per annum.

Where so much depends upon the simplest means that can be adapted to the ready manipulation of irresponsible and unskilled workmen, it is very important to note every appliance which affords facility and promotes economy. This is claimed for the simple contrivance illustrated by the large diagram on the wall, and by a sample lid on the table. It is so simple as to require almost no explanation, and its economical advantages over the present cumbersome and expensive method must at once be obvious to all.

The lid is stamped out of iron plate, with its edge turned up all round; and, in order to make a tight joint, the front of the mouthpiece is turned or faced true, and the upturned edge of the lid is also turned true, and by preference semicircular in section, as shown at A in the diagram, so that the bearing surface of the lid on the mouthpiece is reduced to a minimum. It is made very light, but, being convex in form, it rigidly sustains the force of the screw, which, by its central action, gives the lid a uniform bearing against the mouthpiece, the slightest pressure being quite sufficient to ensure perfect soundness.

The method of applying the lid is quite arbitrary. The sample is provided with ledges, to rest on the ordinary lugs of the mouthpiece; but in making new mouthpieces it is proposed to construct a hinge, so that the lid and crossbar need not be taken off during the drawing and recharging of the retort. This is an important feature, as it will obviate much of the damage

which you all know constantly occurs from the rough usage to which the lids and screws are subjected. Various schemes have been tried, and tried successfully, to prevent this injury to the crossbar and screw, by hinging it to the mouthpiece; but it has hitherto been impracticable to hinge the lids, from the necessity of removing them for the purpose of luting. It will, however, be quite practicable, in the application of the "self-sealing" lid, to secure it to the crossbar; and, by hinging the latter, both will remain attached to the mouthpiece, and the damage now arising from carelessly throwing them about will be entirely prevented.



The lids are made to any shape, but it will be obvious that the round form is the most convenient, as well as the cheapest to make; and, instead of using D-shaped lids, or recommending their adoption, I am making the mouthpieces of D retorts with circular fronts, so as to be able to use a round lid.

A question may be asked as to the cost of the lid. I would answer that, though costing more per cwt., their weight being about two-thirds that of the old, the price, lid for lid, will be pretty much the same.

Mr. ANDERSON said, whether good or bad, he thought there was nothing new in the invention. Some years ago, at Cork, a setting of retorts was fitted up with plain-surfaced lids, but the experiment was not continued. The works at Dublin had all turned-up surfaces. The first patent of Best and Holden's mentioned turned-up surfaces and single mouthpieces. With ordinary lids, if they got out of shape, the luting made up for any differences of surface; but with such lids as those referred to in the paper, he thought they ought to be made heavier instead of lighter, to enable them to keep their proper form, and thus secure perfect soundness at the point of contact with the mouthpiece.

Mr. WOODALL, on the other hand, thought that it was due to the lightness of these lids that Mr. Morton had achieved his success. It was this which enabled the lid to give somewhat, so as to fit the surface of the retort all round. If it were made extremely rigid, it would require immense pressure under the screw to obtain a uniform bearing against the mouthpiece.

Mr. UPWARD said he had examined the lids made by Mr. Morton at the London Gas-Works, and on comparison had found them considerably lighter, lid for lid, than the ordinary D lids. This was attributable chiefly to the form which Mr. Morton had adopted—viz., that of a dome. He (Mr. Upward) had got out the cost of the old method of luting, and found it varied from 16s. to 18s. per annum per mouthpiece for labour and materials purchased, not taking into account the value of the foul lime employed. When he visited the London Gas-Works a few weeks previously, the tightest lids were those without any luting, on Mr. Morton's plan.

Mr. HOLMAN, the maker of the lid, in reply to Mr. Anderson, said it was not a flat surface on the lid; it was simply a flat surface on the mouthpiece. With regard to the lightness of the lid, as there was simply the area necessary to cover the mouthpiece, and it was only 5-16ths of an inch thick, it must be lighter than those in ordinary use. When being fixed it presented the greatest amount of strength as operated upon by the screw, the central action of which brought it to a uniform bearing all round.

Mr. H. JONES thought there was one objection to riveting the ears on to the lid—that they were liable to get loose afterwards.

The time for adjournment having now arrived, the remaining paper on the list, "On Breeze and Tar Fuel," by Mr. G. Anderson, was necessarily postponed, but Mr. Anderson consented to its publication in the transactions of the association.

At five o'clock the members and friends dined together at the Adelphi Hotel.

THURSDAY, JUNE 3.

The members assembled this morning at half-past ten, in the theatre of the Royal Institution, the PRESIDENT in the chair.

An alteration was made in Rule 7, the word "three" being placed before "Vice-Presidents." This necessitated an alteration in Rules 10 and 26, and the expunging of Rule 28.

The SCRUTINEERS presented their report, from which it appeared that the following gentlemen had been chosen by ballot the officers of the association for the ensuing year:—

President, Mr. W. Eson.
Vice-Presidents, Mr. A. A. Croll, Mr. G. Anderson, Mr. M. Ohren.
Treasurer, Mr. Newall.
Committee (to replace the three members going off by rotation), Mr. G. T. Livesey, Mr. J. Paterson, and Mr. Woodall.
Auditors, Mr. Leather and Mr. Newbigging.
Hon. Secretary, Mr. W. H. Bennett.

On the motion of Mr. BARRAS, the thanks of the association were presented to the writers of the various papers brought before the meetings.

On the motion of Mr. COX, seconded by Mr. R. H. JONES, thanks were voted to Mr. Bennett for the services rendered by him to the association since he had acted as honorary secretary.

Mr. BRADDOCK proposed, and Mr. BARRAS seconded, a vote of thanks to the committee for their services during the past year, which was cordially adopted.

The PRESIDENT acknowledged the vote.

Mr. BROADHEAD moved, and Mr. ANDERSON seconded, the following resolution, which was unanimously agreed to:—"That the most hearty thanks of the meeting be given to the sub-committee for their services in making the local arrangements for holding the present meeting, and obtaining permission for the members to visit works and places of interest in Liverpool and the neighbourhood."

Mr. HALL, for himself and his colleagues, Messrs. Paterson and Wood, acknowledged the vote, and said the sub-committee were extremely gratified to find that their exertions had met with the approval of the whole of the members of the association.

On the motion of Mr. ANDREWS, seconded by Mr. JONES, thanks were voted to the scrutineers for their services.

Mr. WARNER acknowledged the vote, and at the same time gave notice that he should, at the next annual meeting, bring forward the question of the propriety of establishing a benefit fund for decayed members.

Mr. ANDREWS said he should be very happy, if present, to second the motion, his only reason for opposing it on this occasion being that he thought it was brought forward irregularly.

Mr. ESSON, in complimentary terms, proposed—"That the thanks of the meeting be conveyed, through the chairman, to Mr. Blackburn, the late secretary of the association, for the able and successful manner in which he discharged the duties of that appointment."

Mr. PATERSON seconded the motion with great pleasure. It was needless to say one word as to the fidelity, zeal, and ability brought to bear by Mr. Blackburn upon the affairs of the association, while he was sure that every one present regretted the absence of Mr. Blackburn from the meeting. They all felt that his mantle had fallen upon one who was well qualified to advance the interests of the association, and carry on the work which Mr. Blackburn so ably sustained from the outset.

The PRESIDENT said it was hardly necessary to put the motion, as he was sure there was a unanimous feeling in its favour.

The resolution was most cordially adopted.

On the motion of Mr. ESSON, it was unanimously resolved—"That the most cordial thanks of the association be presented to Ebenezer Goddard, Esq., for the unwearied interest and attention he has at all times devoted to the various duties devolving upon him as president, in promoting and advancing the interests of the association during his year of office; also for the scientific inaugural address delivered by him, and for the kindly feeling and urbanity of manner evinced by him to every member in presiding over the business of this meeting."

The PRESIDENT acknowledged the vote.

A conversational discussion ensued as to the time and place for holding the next annual meeting, and it was ultimately resolved—"That the next annual meeting of the association be held in London, to commence on Tuesday, May 31, 1870."

Mr. METHVEN proposed, and Mr. ANDREWS seconded, the appointment of Messrs. Goddard, Hawksley, and Newall as trustees of the surplus funds of the association.

Mr. CRAVEN called attention to the question of the rating of gas-works, and expressed a hope that some experienced member would consider the subject, and submit a paper thereon to the next meeting of the association.

Mr. WARNER suggested that the committee might take into consideration the propriety of having a popular lecture delivered to the public in connexion with the annual meetings of the association.

The PRESIDENT said the suggestion might be worthy of some consideration; but it must not be forgotten that they met as practical men, and required to have such matters brought before them as would be advantageous to the companies with which they were connected. He thought it would be desirable if gentlemen who held office as managers in the provinces would get up lectures for their own districts, so as to enlighten the people around them, and help to remove some of the prejudices which existed against the operations of gas companies.

This closed the business of the association, and the remainder of the day was spent in visiting various places of interest in the neighbourhood.

Messrs. C. and W. Walker, of the Midland Iron-Works, Donnington, near Newport, Shropshire, sent three large drawings to the meeting of the association, illustrating their improvements in the construction of purifiers, and bringing specially before the notice of the managers of gas-works the great importance of the saving of manual labour in the working of large purifiers, by adopting specially constructed tilting trucks or waggons, travelling on railways, for charging and discharging the oxide or lime.

This was one of the chief features of the drawings, and for this purpose the purifiers were shown fixed half below and half above the ground-line, with the entire surface of the purifying-house floor kept clear for working and for travelling the tilting-trucks upon the lines of rails directly alongside the purifiers.

The lifting and travelling of the purifier-covers was shown by a travelling crane upon wrought-iron trellis girders, fixed overhead along the centre of the purifiers, and out of the way of everything.

The purifiers, for the same reason, were shown worked by C. and W. Walker's patent centre-valve, including Messrs. Cockey's patent, by licence, and this, with all the pipes and connexions, is fixed beneath the floor-line, in order to leave the floor clear and be out of the way of everything. The tilting-trucks were shown arranged for one man to travel a ton weight of oxide or lime along the line of rails, and, on arriving alongside a purifier, he simply releases a catch, and the truck tilts over, and discharges the oxide or lime right into the purifier on to the grids.

By another line of rails the purifiers are similarly emptied, and the truck tilts over and discharges the oxide direct on to a grated floor, being thus at once exposed to the upward draught of atmospheric air circulating freely through it, and accomplishing the chief part of the process of revivifying by a large saving of labour that would otherwise be required in shovelling it over and over.

The drawings of the buildings illustrated them as laid out expressly for the above working arrangements, and of exceedingly moderate cost, con-

sisting of a roof formed of ventilating tiles laid upon iron principals and laths, supported upon iron columns, the air circulating freely through the tiles over the entire surface of the roof.

The drawings showed the before-mentioned working arrangements for purifiers fixed in line or in square, and a sectional end view of the building, showing the construction of the ventilating grated floor for revivifying the oxide, the construction of the roof, and the travelling tilting-trucks.

At the meeting on Tuesday evening the following lecture was delivered by Alfred G. Anderson, Esq., Professor of Practical Chemistry at Queen's College, Birmingham:—

ON SOME NEW CONTRIBUTIONS TO THE CHEMICAL AND TECHNICAL HISTORY OF COAL GAS.

Mr. President and Gentlemen,—While it is with very great pleasure I have the honour to present myself this evening as lecturer, to bring before your attention some new contributions to the chemical and technical history of coal gas, I must confess it is not without some degree of concern that I do so. I feel that, while undertaking to submit new matter, as associated with coal gas, to your notice, I have taken upon myself a task of no ordinary difficulty. I cannot but feel that some degree of contrast may be instituted between myself and the distinguished chemists, Drs. Letheby and Odling, who have preceded me in these matters; and of course it is hardly possible that it can be otherwise than disadvantageous to myself, if any such comparison be instituted between us. It is, therefore, quite imperative that I ask your indulgence towards such an effort as I shall make this evening to bring what I have undertaken before your notice—viz., some few facts connected with the chemistry of coal gas. I must beg leave to assure you that I have bestowed every care to place myself in a position to submit to your consideration such new matter as I have observed in the pursuit of the study of this branch of chemistry, to which I have devoted considerable attention. I fear, however, in the first place, it will be necessary—unwilling as I am on my part—to go over some ground which I expect has been thoroughly travelled over before you by my predecessors in office.

I propose to begin by first recalling to your remembrance the two classes of constituents of coal gas, one of which I hope to present to your notice associated with some new features of interest. Gentlemen, I know it will not be new to you when I proceed to say that there are two distinct classes of constituents of coal gas—one class communicating to the gas all its illuminating power; another, the exact relations of which I find have not hitherto been thoroughly understood. These latter have always been called non-illuminants.

On the board before you I have placed the names of certain bodies which I have no doubt are tolerably familiar to you. They are as follows:—

1.—ILLUMINANTS OF COAL GAS CLASSED TOGETHER.

Marsh gas.	Butylene.
Olefiant gas.	Hydrocarbons.
Propylene.	Benzole vapour.

Acetylene.

2.—SO-CALLED NON-ILLUMINANTS OF COAL GAS, ALSO ALWAYS CLASSED TOGETHER.

Hydrogen.	Carbonic oxide.

I wish to direct your attention to one of these as the suitable representative of class 1—viz., olefiant gas. It is not necessary that I should enter into a minute description of the burner I am about to employ for the purpose of exhibiting its illuminating properties; it is sufficient to say that it is a burner of the Argand construction, by which gas can be burned under the ordinary conditions of admission of atmospheric air to the flame. I have here an arrangement by which I can apply a suitable amount of pressure by means of water supply from this elevated tank, and as this gas is the only representative of the class I am going to bring under your notice, it will be worth while to observe, as far as we are able, the time occupied in its combustion. [Experiment performed; the olefiant gas being burned by an Argand jet, screwed into the top of a graduated gas bottle, as it was displaced by the inflow from a 5-feet head of water in the tank.] I will content myself here with drawing your attention to the light-giving properties of this gas as a fair representative of its class.

Now I pass on to say something of the nature of the *non-illuminating* constituents—carbonic oxide and hydrogen. (Diagram 2.) Unfortunately—although this, I hope, will prove of little importance to us—the duration occupied by the combustion of the bulk of gas we can confine inside this jar can hardly be ascertained with the degree of accuracy I could wish to attain, to enable us to clearly observe the singular contrast in this regard between the compound carbonic oxide and the elementary body hydrogen, to both of which, in a few minutes, I hope to call your attention when burning them by this jet.

Now I must make a remark or two concerning the nature of the non-illuminant bodies—carbonic oxide and hydrogen gas. The former you may probably know is a compound of oxygen with carbon—one volume of carbon vapour being combined with one volume of oxygen. Now I have in this gasholder some carbonic oxide—of which coal gas contains from 5 to 16 per cent.—made a few hours since, and I will transfer a bulk of it into this vessel. For this end I make a communication between the Pepy's gasholder and the gas bottle, with this pipe. Then by the water-pressure, caused by turning this tap, I thus fill the jar with the gas. Now that I have filled the vessel, we will turn down the lights in the theatre, and examine with great care the peculiar blue flame which we shall get when we burn the carbonic oxide by the same burner that we employed in the combustion of the olefiant gas. [Experiment performed.]

I shall draw your attention, in a few minutes, to the nature of the flame presented by the other non-illuminant constituent, and which you see, from the diagram, is called hydrogen. When we then compare the burning flames of the carbonic oxide and the hydrogen, you will at once see that, although these two gases have always been classed together, we shall perceive, by the nature of their respective flames, and their duration of combustion at this burner, that there exists a very manifest difference between them.

We will now, if you please, proceed to compare other results that we shall get by the performance of one or two more experiments, which I must now submit to your notice. Let me first, however, once more repeat the experiment of burning carbonic oxide, as performed in our last experiment. [Experiment performed.]

Now, the flame of carbonic oxide presents a curious circle of spiked points upon the ring of the Argand, and we cannot increase its combustion by this burner without blowing it out, by reason of its inherent limited combustibility.

Sometimes it produces, under these conditions of combustion, remarkable musical notes, similar to the Æolian harp, and loud enough to, as I may say, fill this lecture theatre. I cannot, however, I must mention, produce these curious sounds at will, for I have not yet succeeded in finding the cause operating in their production.

We are consuming here a mixture of the vapour of carbon and oxygen, bulk for bulk. Let us not forget this. It is of no use for me to attempt to increase its rate of combustion; if I do so, it will inevitably go out. [Shown.] I will increase its supply to the burner to the maximum, and you, I think, will be able to perceive, notwithstanding, how slowly it burns on the surface of the burner; and also, when I come to compare it with the other non-illuminant, how slowly it burns in comparison with hydrogen.

We have, in carbonic oxide, a gas which is very rich in carbon, for I have said that every half bulk of it contains nothing but carbon vapour, the rest being oxygen gas; yet we perceive, from these experiments with the burner, that its illuminating power is *nil*. Bulk for bulk, there is just the same proportion of carbon vapour (I may call it carbon gas) in light carburetted hydrogen as that contained in carbonic oxide. The only difference is, that the carbon, in the case of the first, is in combination with hydrogen; in the second, of course, with oxygen. But we arrive at a prodigious distinction when we examine the flames of these in regard to illuminating properties. Carbon vapour, united in large proportion with oxygen *or with nitrogen*, though in both instances furnishing highly inflammable gases, can give no light. We most of us, I believe, know, on the other hand, the illuminating brilliancy possessed by all the gaseous compounds of carbon vapour with hydrogen. It is hardly within my province—my inquiries on this interesting subject are scarcely so mature—as to enable me to enter any further, on this occasion, into this division of my subject.

Having drawn your attention to the flame of carbonic oxide, I pass on to compare it with the flame which we get emitted from the same burner when we use hydrogen gas.

We evolve hydrogen gas in a moment from zinc: oil of vitriol, and some water; and we will fill this flask with the hydrogen gas so evolved, and see its combustion by the same burner. Doubtless you are aware that this non-illuminant is not a compound like carbonic oxide, but what is called by chemists an elementary body. Also, that it forms 1-9th by weight of water, from which it is very commonly prepared. It is found present in coal gas, in proportions generally varying from 25 to 60 per cent. It is highly inflammable.

Now, I may here say that my object to-night will be principally directed to showing you that the two bodies, hydrogen and carbonic oxide, which in this diagram I have placed under one head, in deference to accepted doctrine, as non-illuminants of complete identity, of coal gas, hitherto classed together, have no right to be so classed together. I believe that I shall succeed to-night in demonstrating this to you. They differ in many ways most essentially, and, to begin with, we may first with propriety examine the difference in the flames of carbonic oxide and hydrogen, and then I shall proceed to show you that, when burned in association with hydrocarbons, one seriously affects—destroys—their illuminating power to a very great degree, while the other does not.

The flame of hydrogen, I quite expect from your former experience at these lectures, is not unknown to most of you. [Flame from single jet exhibited.]

Now let us see what appearances we get when we burn this hydrogen under the same circumstances as we did the carbonic oxide in the Argand burner, and then compare together the two results. [Some hydrogen was then prepared from pure zinc and H_2SO_4, and collected in the gas bottle. When the vessel was filled with the gas, the same water-pressure was applied as employed with the carbonic oxide, and the hydrogen was burned by the Argand jet.]

You will notice the peculiar conical shape of the flame of this hydrogen gas. I do not know whether it is perceptible to you at a distance, but it appears to me as a conical bluish-yellow flame. At the upper surface of each hole small sharp-pointed light-coloured pencils, somewhat similar to the pointed flame of the carbonic oxide which I was exhibiting a little while since, show themselves.

It is often barely possible, in the limits of a lecture, to do more than bring out evidences of contrast by way of illustration. It must, I think, have been very clear to you that, besides the flames, the duration of combustion observed with carbonic oxide and hydrogen differs in a striking degree. I have hinted that the means at command at a lecture-table do not allow me to prove this with perfect precision before you. But I am able to supply this want from many experiments of accuracy made in my laboratory, and I find that, comparing bulk for bulk, or volume for volume, hydrogen burns in about one-third of the time occupied by carbonic oxide, the same burner being used to consume them.

I need, I think, hardly point out the application of these two duration demonstrations in reference to gas supply. Irrespective of illuminating power, it is obvious that gas containing a large proportion of hydrogen must burn with increased rapidity, and *vice versâ* for carbonic oxide. It is an established fact that both of these ingredients in proportion are subject, as I have mentioned, to very considerable variation. Hence may be accounted for considerable discrepancies sometimes observed in meter registration, while the light furnished has been singularly constant.

Well, I want now to show you what is the result of burning half volumes of carbonic oxide, mixed either (by way of illustration) with olefiant gas; or I prefer to take, as more convenient—while yet equally exemplifying what I have to bring under your notice—coal gas. I propose, in a minute or two, to make an experiment founded on this principle—the results are so demonstrative.

This will bring us to the third and last point which I propose to submit to you, regarding these non-illuminants class—carbonic oxide and hydrogen. I shall show that carbonic oxide gas, in a most important way, controls the development of illuminating power in coal gas combustion; so also does hydrogen. I do not propose—time would not permit me—to take the exact photogenic value of gases in which we have the same proportion of illuminating hydrocarbons, mixed in one case with carbonic oxide, in another with hydrogen, for our experiments of comparison; but what I shall succeed in showing to you is this, that where, as in this diagram (No. 2), the non-illuminating ingredients of coal gas are, as they hitherto have been, classed together, it has been done improperly; because the exact part that hydrogen plays, and carbonic acid plays, as constituents of coal gas, has never yet been exactly ascertained; and my inquiries have shown to me that their functions in this regard are entirely different.

(To be continued.)

IMPERIAL AUSTRIAN GAS COMPANY, LIMITED.—The liquidators have given notice of their readiness to pay in full the whole of the claims proved against this company. The payments will be made on Monday, Aug. 9, at the offices of Messrs. James, Edwards, Cash, and Stone.

A CHEMIST'S VIEW OF THE SEWAGE QUESTION.

By EDWARD C. C. STANFORD, F.C.S.

(*Continued from page* 595.)

SECOND PAPER.

[Read before the Chemical Section of the Glasgow Philosophical Society, April 19, 1869.]

About twelve months ago I read a paper on this subject before the Sewage Association of Glasgow; since then the members of that association, with all their varieties of opinion, have passed one unanimous resolution—that, whatever system be adopted, the excreta must be kept out of the public sewers, the expression of a conviction which will be that of any patient inquirer into this difficult question.

In the paper referred to I endeavoured to show that, whatever may be the best, the present water-closet system, with all its boasted advantages, is the worst that can be generally adopted; briefly, because it is a most extravagant method of converting a mole-hill into a mountain. It merely removes the bulk of our excreta from our cities, to choke our rivers with foul deposit, and rot at our neighbours doors. It increases the death-rate, as well as all other rates, and introduces into our houses a most deadly enemy, in the shape of the sewer gases.

Since then the report of Messrs. Bateman and Bazalgette has appeared, and it proposes (what every one knowing the views of the authors would at once have predicted) to put down miles of costly sewers to carry the excreta to the Ayrshire coast, where, perhaps, the inhabitants may oblige us to take it back again; in other words, to commit the error of London, and wake up in a few years to the same bitter repentance.

We cannot be surprised at this; we cannot expect homœopathic treatment from an allopathic physician, especially if, as in this case, "bleeding" is to be again the universal cure. The engineer's treatment of town excreta always reminds me of the country doctor in America, who put all his feverish patients through a course of convulsions, because, though he didn't understand *fevers*, he *could* cure *fits*. In our numerous discussions I have always maintained that chemists have been most unfairly treated in this matter. The public like to see what they pay for; they can see bricks and mortar, and therefore have allowed engineers to give them an intimate pocket-purse knowledge of this expensive commodity, for which they have paid, in more than one sense, through the nose. Engineers have too fondly believed that water is the great purifier, and so they dilute the excreta with 365 times its bulk of water, and reduce its value to 1d. per ton, and then turn round on the chemist and expect him to reverse the process, pick out the penny, and repay the expenditure. Now, if it were a simple mixture—if it were only to separate the grain of wheat from the sack of chaff—the problem would be difficult enough; but we know the case to be far worse than this—it is the handful of yeast in the sack of flour that we are called upon to extract, and the fermentation of which we are expected to prevent, *after* it has occurred. A small portion of dilute sewage mixed with a large excess of water soon renders it all equally offensive, and the problem of extracting its value is one which no chemist need ever attempt to solve.

The water-closet, with many apparent advantages, and with all our prejudices in its favour, carries an attendant train of evils, which I am fully persuaded will ultimately doom it to oblivion.

As, therefore, engineers have not put the subject fairly before chemists, I propose to take a noble revenge, and put the subject fairly before engineers. I ask them why they consider water to be the only vehicle for removing excreta? why not earth? why not air? Have they ever fairly investigated or thoroughly experimented on the other methods? Have they not rather confined their studies to *fits*, and forgotten *fevers*?

So many attempts have been made by chemists to pick up the halfpence that engineers have so plentifully flung into the mud, that I cannot even notice them, except to remark that, in the opinion of all the scientific chemists who have specially investigated these attempts, they have all signally failed.

I must allude, however, to the process of Mr. Chapman, as one of the latest methods of dealing with town sewage. This is a process of distillation, after treatment with lime and thorough putrefaction. He, however, confesses his difficulty, by wishing to reduce the sewage of this city from 31 million gallons to 1 million gallons daily. This, of course, requires a complete alteration in the existing system, and it still dilutes the excreta with more than ten times its bulk of water. The lime process, and the putrefaction required to decompose the urea, would be extremely offensive, and require vast storing-tanks. In working 1 million gallons daily (it would more probably amount to 2 million gallons), he would have to treat 4464 tons daily, the total chemical (not the extractible) value of which is 2s. 6d. per ton; and he expects to do this with 20 tons of coal. He proposes to adopt an ingenious arrangement of eight boilers, steaming exhaustively, to distil off the ammonia, heating up the feed sewage, after precipitation by lime, by the hot water discharged from the boilers, by a kind of brewhouse refrigerator with its object reversed. He expects to distil off 1-12th; but I think it must be at least 1-10th, or 100,000 gallons, evaporated by 20 tons of coal = 5000 gallons to 1 ton. The report of Professors Lyon Playfair and Johnstone puts the average evaporation for Scotch coal at 7·7 tons, or 1712 gallons per ton, and at this rate 58 tons would be required for the mere evaporation. Then, for raising the heat, the same report says that 1 ton of Scotch coal raises 56 tons of water from 32° to 212° Fahr., or, say, 50 tons of water from 52° to 212° Fahr., requiring, therefore, 96 tons for heating up, making a total of 148 tons a day. Mr. Chapman, therefore, expects to save, by heating feed water and by exhaustive steaming, a total of 128 tons of coal daily, or 600 per cent. Can this be done? If it can, then whatever may be the result of his process, as applied to sewage, it will make him the greatest and most daring authority on that equally important subject, the economy of fuel. He puts down no loss for radiation. This should, I think, be at least 10 per cent., which would require nearly as much as his total calculated expenditure for fuel. In using eight boilers, of 4000 gallons each, he expects to get off all the ammonia in half an hour's steaming. Now, we all know that the estimation of free ammonia in the laboratory is one of the most tedious processes, requiring a long-continued ebullition; and the experience of distillers, on the large scale, amply corroborates this, and proves that it does not pay to distil liquors containing under 1 per cent. of ammonia (some manufacturers double this estimate). The total amount in the sewage to be distilled would be under 0·2 per cent.; I think, therefore, that the process of Mr. Glassford, of evaporation with sulphuric acid (for which I must refer you to his pamphlet on London sewage), is better than this. Fuel is the great question in both, but in his the results are certain, in Mr. Chapman's they are problematical.

Both are, however, connected with the water system, which I believe to be a mistake, and I think we must ultimately come either to a system like Captain Liernur's, by what may be called pneumatic despatch, or to the dry-closet system. Of the former I have fully treated in a former paper, and wish now to speak more particularly of the latter. During the past year Moule's dry closet has been largely introduced; all who have used it speak in the hightest terms of its efficiency, and there are already strong indications of its becoming the system of the future. It is the only system that has succeeded during the hot fortnight at the Wimbledon meeting; and it is particularly adapted to hot climates, where the evils of the water-closet are most conspicuous. The objections urged against the system, when earth is used, are, first, the large quantity of earth required—three and a half times the weight of the excreta; and, secondly, the difficulty of obtaining the quantity reduired, and of drying it. Now, both these difficulties are disposed of by using charcoal. I employ, by preference, seaweed charcoal, because it is the most porous, the best absorbent, and the cheapest. It only requires one-fourth of the weight, compared to earth; and when the mixture is removed and placed under cover, it soon dries. This mixture can be stored for any length of time, and used again several times. When convenient, it is reburned, like the char in sugar refineries, except that this process is carried out in apparatus which admits of collecting the ammonia and other products condensed. The whole of the ammonia is thus collected; whilst the phosphoric acid, potash, and mineral matters accumulate in the charcoal, together with the carbon from the organic constituents of the excreta. The weight of the charcoal is increased to the extent of about 5 per cent. with each using, and, if dried and re-used five times, about 25 per cent. with each reburning. With this constant addition the char does not require replacing with fresh material, so that its cost is only a primary outlay—the ultimate result being that the excreta is deodorized by a charcoal derived from itself, and a company working this process would, in addition to securing the whole of the ammonia, become sellers of a charcoal second only in value to that from bones, to the extent of, in Glasgow, if the process were general, 19 tons a day, or 6935 tons a year; the total quantity of excreta which Glasgow has to remove being 385 tons a day, and its value, at 29s. 6d. per ton = £569.* The ultimate result being the same, any charcoal may be used at first. The process is carried out without odour, from the closets to the finished products. Of course the process may be modified; for instance, suppose the char to be used five times, and only dried, the addition to its value would be as follows (I take equal parts, as this charcoal will absorb at least an equal weight of even urine):—

1 ton seaweed char, at £2 } = 30 cwts. manure at £9 7s. 6d.
5 tons excreta, at 29s. 6d. } = £6 5s. per ton.

Or, if reburnt, it would yield 25 cwts. of charcoal, and the whole of the nitrogen would pass over, in the distillation, as ammonia. Dr. Wallace estimates the cost of reburning char in sugar refineries at 3s. 6d. per ton for labour and fuel, containing 31 per cent. moisture, which would be much over that referred to. Here, then, we have a simple process for recovering the whole of the value from excreta, of general application, and the results of which can be predicted by chemists with absolute certainty, as far as those products to which we at present attach value are concerned; but the uncertain portion is, as usual, the most interesting, for in the destructive distillation of the excreta we are exploring a new field, which promises great interest.

I regret that I am obliged to bring this paper forward before the new products have been studied. The distillation generally is remarkably similar in its products to that of bones, and also to that, which most resembles it, of seaweed. Besides ammonia, acetic acid, with a little butyric acid, acetone, and pyrrol are the most marked bodies. I cannot speak more definitely of these products in this paper, as they are still under investigation. The following analysis of urine is taken from Miller, representing the average composition in 1000 grs., specific gravity 1·020. The calculated per centage of nitrogen is appended:—

		Nitrogen.	In 100 Parts of Solid Matter.	Nitrogen.
	Water	956·80		
Solid Matter, 43·20. Organic, 29·97.	Urea	14·23	6·64	33·08 — 15·40
	Uric acid	0·37	0·12	0·86 — 0·27
			6·76	15·67
	Alcoholic extract	12·53	29·03	
	Watery extract	2·50	5·80	
	Vesical mucus	0·16	0·37	
Inorganic, 13·35.	Chloride of sodium	7·22	16·73	
	Phosphoric acid	2·12	4·91	
	Sulphuric acid	1·70	3·94	
	Lime	0·21	0·49	
	Magnesia	0·12	0·28	
	Potash	1·93	4·47	
	Soda	0·05	0·12	
		999·94	100·00	

NH₃, 8·2. Sulphate of ammonia, 31·86, or 3·18 per cent.

NH₃, 19. Sulphate of ammonia, 73·72.

The average portion voided by each individual may be taken at 40 ozs., and of fæces, 4 ozs., total 44 oz. daily; or, 1·7 ozs. solid from urine, and 1 oz. solid from fæces = total of 2·7 ozs. solid excreta daily. The following analesis of the fæces is from Berzelius:—

Water	75·3		
Bile	0·9	5·7	Containing, according to Playfair—
Albumen	0·9		15 per cent. nitrogen, and 45 per cent. carbon, and about 25 per cent. ash.
Extractive matter	2·7		= nitrogen 3·75 per cent.
Salts	1·2		= 4·55 NH_3.
Insoluble residues of digested food	7·0	7·0	= 17·65 per cent. sulphate of ammonia.
Insoluble matters added in intestinal canal — mucus, biliary resin, and peculiar animal fat	12·0	12·0	= 70·71 in dry solid matter.
	100·0		

Solid matter, 24·7.

The ash contains, according to Porter:—

	Ash of Fæces.	Ash of Urine (calculated).
Chloride of sodium	1·33	54·15
Phosphoric acid	36·03	15·89
Sulphuric acid	8·13	12·73
Lime	26·46	1·57
Magnesia	10·54	0·89
Potash	6·10	14·45
Soda	5·07	0·38
Peroxide of iron	2·50	—
Carbonic acid	5·07	—

Assuming, then, the proportions voided to be in the proportion of 17 dry, from urine, to 10 dry, from fæces, the resulting chars may be expected to have the following composition:—

* Value given in my former paper.

	Urine.	Fæces.	Mixed Excreta.
Per centage of char in dry sold matter	50	70	57
Ammonia = sulphate	73·72	70·71	72·60

COMPOSITION OF CHARS.

	Per Cent.	Per Cent.	Per Cent.
Carbon	33·33	45·00	37·65
Chloride of sodium	36·10	0·33	9·51
Phosphoric acid	10·60	9·01	10·01
Sulphuric acid	8·49	0·78	5·63
Lime	1·05	6·61	3·11
Magnesia	0·60	2·63	1·35
Potash	9·64	1·52	6·63
Soda	0·26	1·26	0·63
Peroxide of iron	..	0·62	0·23
Carbonic acid	..	1·26	0·46

The nitrogen in the mixed excreta, in the proportions voided, is equal to 4·49 per cent. of sulphate of ammonia.

In the char from urine the phosphoric acid is principally combined with potash, and therefore soluble. This char alone would be a valuable manure, as containing a large proportion of soluble phosphates; but the result of commencing with seaweed charcoal, which is rich in carbonate of lime, will be to form phosphate of lime at the expense of the carbonate; in other words, to form, by treatment with urine, reburning, and washing, the animal charcoal required by the sugar refiner. This expected result is verified in the following tables of analyses. I regard the phosphate of lime thus gradually formed, from its minute state of division, to be quite equal, in agricultural value, to ordinary soluble phosphate. The washed residual char from fæces is at once available for the refiner, as it contains about 26 per cent. of phosphates of lime and magnesia, with but a small proportion of carbonate. I know no reason why the product of disintegrated bone and muscle should not be used for this purpose as well as the bones themselves.

In distilling 100 tons of the dry product from mixed excreta, therefore, we should obtain 72 tons of sulphate of ammonia, and 57 tons of a charcoal containing 10 per cent. of phosphoric acid in its most available form for manure, and 6 per cent. of potash. It will be seen, from Berzelius's analysis, that nearly 50 per cent. of the fæces consist of fatty matter. How will this appear in the distillation? In a population of 500,000 this item amounts to nearly 7 tons a day!

I expected a loss of ammonia in drying, but it is very small, and appears to arise from the free lime in the char, as it will be seen further on that the loss decreases in using the char with urine. In a small experiment with urine, I found the total loss, in drying by artificial heat with new char, to be 2·06 per cent. of the ammonia, or ·105 per cent. of the urine employed.

I append analysis of 1 lb. of char which was reburnt 15 times with an equal weight of urine. A portion of the char was lost, which prevents my giving the increase in weight; I believe, however, the addition of carbon would be too slight to effect an increase in the total, with so many reburnings. The per centage is decreased:—

	Char used.	After reburning.	Increase per Cent.
Water	10·0	2·80	—
Soluble salts	0·6	11·15	10·55
Insoluble	89·4	86·05	—
Soluble.			
* Chloride of sodium	..	8·75	8·75
Sulphuric acid	0·3	0·34	0.04
Phosphoric acid	..	2·00	2·00
Potash	0·3	2·40	2·10
Insoluble.			
Carbon	54·4	29·40	—
Silica, &c.	9·1	13·10	4·00
Phosphate of lime	4·8	20·05	15·25
Carbonate of lime	17·4	19·75	2·35
Carbonate of magnesia	3·4	3·40	—

The urine used appears to have been deficient in sulphates and high in phosphates, these two ingredients being subject to considerable relative variation. The distillates gave 192 ozs. liquid, containing free ammonia equal to 3047 grains sulphate, or 2·9 per cent. of the urine, showing a slight loss, inseparable from destructive distillations on the small scale. The charcoal should be used at least five times before reburning, and for urine alone it may be employed ten times. I append a table, showing the analytical results of this process with urine:—

* In this and the following analyses, the whole of the chlorine has been calculated, for convenience, as chloride of sodium, which, in some cases, is therefore too high.

	Increase per Cent.				Increase per 1000 Grs. of Urine.			
	1.	2.	3.	4.	1.	2.	3.	4.
Dry solid matter	33·30	62·50	210·00	347·94	33·30	31·25	42·00	34·79
Char	7·50	12·90	80·40	151·96	7·50	6·45	16·40	15·19
Ammonia sulphate	21·70	36·80	51·12	105·64	29·00	29·90	31·60	47·31

RESIDUAL CHARS.

	Ordinary Char.	Composition per Cent. 1.	2.	3.	4.	Increase per Cent. 1.	2.	3.	4.	Increase per 1000 Grs. of Urine. 1.	2.	3.	4.
Water	10·00	1·60	3·00	—	—	—	—	—	—	—	—	—	—
Soluble salts	0·60	15·80	19·80	39·40	52·20	15·20	19·20	38·80	51·60	20·40	15·70	24·30	22·78
Insoluble	89·40	82·60	77·20	60·60	47·80	—	—	—	*41·60	2·04	23·90	19·60	12·47
Soluble.													
Chloride of sodium	—	5·40	13·10	28·02	24·70	5·40	13·10	28·02	24·70	7·18	10·60	17·30	11·06
Sulphuric acid	0·30	2·05	3·29	3·77	3·77	1·75	2·99	3·47	3·47	2·33	2·64	2·21	1·62
Phosphoric acid	—	2·20	0·40	trace	1·60	2·20	0·40	—	1·60	2·92	0·32	—	0·71
Potash	0·30	2·80	4·99	7·00	10·38	2·50	4·69	6·70	10·08	3·32	3·89	4·10	4·62
Insoluble.													
Carbon	54·40	37·40	40·00	35·40	28·20	—	—	—	*26·20	*4·50	5·30	11·06	7·19
Silica, &c	9·10	13·60	10·00	8·00	4·40	4·50	0·90	—	*4·60	8·98	3·57	3·14	1·06
Phosphate of lime	4·80	8·00	9·60	11·40	10·20	3·20	4·80	6·60	5·40	5·84	5·40	6·10	4·08
Carbonate of lime	17·40	20·40	13·20	4·20	1·15	—	—	—	*16·25	9·73	2·00	*0·88	*1·22
Carbonate of magnesia	3·10	5·40	3·16	1·93	1·20	2·30	0·06	—	*1·90	4·08	0·98	0·57	0·23

* Decrease.

WASHED CHARS.

	rdinary Char.	Composition per Cent. 1.	2.	3.	4.	1.	Increase per Cent. 2.		
Carbon	54·40	45·30	51·80	58·40	59·00	*9·10	*2·60	4·00	4·60
Phosphate of lime	4·80	9·60	12·40	18·80	21·34	4·80	7·60	14·80	16·54
Carbonate of lime	17·40	24·60	17·10	6·90	2·40	7·20	*0·30	*10·50	*15·00
Carbonate of magnesia	3·10	6·50	4·10	3·10	2·51	3·40	1·00	—	*0·59

* Decrease.

No. 1 is from charcoal dried up with ten times its weight of urine before reburning; No. 2 has been treated with 20 times its weight, No. 3 with 50 times its weight, and No. 4 with 100 times its weight of urine before reburning. It will be seen that in No. 4 more than the theoretical amount of ammonia is obtained; that from Nos. 1, 2, and 3 is obtained by simple destructive distillation. No. 4 only yields ammonia equal to 50·48 per cent. of sulphate when heated in this way, the quantity given, 105·64 per cent., being that obtained with soda-lime; the residual nitrogen is not left in the char, but goes off in the distillation in some other form than ammonia. I shall recur to this subject in a subsequent paper. The retention of nitrogen after drying is, however, extraordinary, when the product yields ammonia equal to 105 per cent. of sulphate. No Peruvian guano can be compared to this in fertilizing value.

The washed chars acquire the composition which fits them eminently for the sugar refiner.

The experiments with closet excreta are unfinished, and it is difficult, in working on small quantities, to obtain uniform results. We find one of Smith's dry closets uses ½ lb. of seaweed char per charge, the charge of dry earth being 2 lbs. Moule's closet uses rather less. There were seven uses in our first experiment, the contents of the pail being reburnt at once, without drying.

Weight before distillation . . . . . 130 ozs.
Residual char weighed . . . . . 48 „
Weight of excreta 82 ozs. = 11·7 „ per use.

The distillation gave 66 ozs. of gas liquor containing free ammonia = 2·8 ozs. sulphate = 3·4 per cent. of mixed excreta; this represents only the free ammonia, or that existing as carbonate; a portion is combined with acetic acid, which was not estimated.

The same method is equally well adapted for treating pot ale from distilleries, and blood and offal from slaughter-houses. The former is an important subject in Glasgow, and I can, in this paper, only shortly allude to it. According to Dr. Wallace, one of the distilleries in Glasgow sends into the sewers 83,000 gallons of this pot ale, containing nitrogen equal to 118 grains of ammonia per gallon; so that the daily discharge of this one distillery is equal to the total excreta of 48,970 persons, or one-tenth the population of Glasgow.

The process can be adapted with ease to urinals as well as closets. I am enabled to exhibit some mixtures of charcoal and night-soil made twelve months ago. I was curious to know if these mixtures had gone further in the oxidation of the ammonia, and formed some nitrates, but not a trace can be detected.

I submit that the dry-closet system, with this process, has the following great advantages:—

1. Total freedom from all odour. All must have noticed sometimes the sickly odour of a water-closet, arising, not from the excreta, but from the gas from the sewers.

2. Certain prevention of all contamination and spread of infectious diseases arising from sewer leakage into our wells or sewer gas into our houses.

3. Saving of water, equal, in Glasgow, to £40,000 a year, if the water-closet system were general.

4. Saving of expense in repairs and removal. 1 cwt. of charcoal per month is sufficient for each closet when used by six persons daily, and the whole may be allowed to fall at once from the closet, through a 12-inch pipe, to a cesspit below the house. A cesspool is a serious evil, but I know of no evil to a cesspit.

5. By this process alone can the whole of the valuable material be recovered for our lands.

Dr. Fergus has shown some remarkable examples in which gastric fever has been traced to the escape of sewer gas through small openings eaten through the top of the soil-pipe. This appears to be a wide-spread evil. I have examined some of these specimens, and find the substance to be a sort of lead plaster, containing also lime and some fatty acid, which requires further examination. I have shown that only remedial measures can be adopted, where the water-closet system has been carried out, by placing boxes of charcoal in the closets, and filtering the sewage through charcoal before allowing it to enter rivers.

Our authorities want, of course, some grand scheme; but they forget that the question is one of minute details. We are assailed by a large army of small nuisances—one, at least, to every house—and we must attack them one at a time. Attacked in their united strength, they will assuredly overcome us. Ought we not rather to strike at the root of the evil? Ought we not to stop the mischief at its numerous sources, and before these can combine into a mighty force, which carries everything before it?

Let the subject be calmly and carefully discussed; let us not be carried away by great schemes and useless expenditure; let us not leave to posterity heavy taxes, with barren wastes and desolate cities; but let us rather pay our own way, and leave our country fertile and our towns pure, and I shall never regret that, however imperfectly this subject has been brought before you, my earnest wish has been to strike "one more blow for life."—*Chemical News.*

DEVONPORT GAS AND COKE COMPANY.

The Annual Meeting of the Devonport Gas and Coke Company was held on the 26th ult., at the Offices, Keyham—Mr. R. C. Smith, chairman of the board of directors, presiding. There was not a large attendance.

The report, which was taken as read, stated:—

The quantity of gas made during the year is about the same as that of the preceding year; the long and brilliant summer season had a tendency to lessen the consumption of gas, and caused a considerable falling off on the first quarter, which has not been altogether recovered during the subsequent quarters.

The gas and meter rental for the year ending the 31st of May last amounted to £13,172 5s. 8d., as compared with £13,269 9s. in the preceding year. The proceeds derived from the sales of coke, tar, breeze, &c., amount to £2236 5s. 8d., compared with £2149 13s. 9d. in the preceding year.

The gross revenue for the year has been £15,408 11s. 4d., as compared with £15,419 2s. 9d. in the former year. The expenditure, including wear and tear, depreciation of plant, wages, carbonizing, and establishment charges, amounts to £11,657 3s. 4d., which leaves a balance to the credit of profit and loss of £3751 8s.

The capital account has been stationary. The loan account shows an increase of £1000 on the preceding year, of which the sum of £350 has been paid off since the balance-sheet was made up.

The directors recommend that a dividend be now declared of 4s. 6d. per share on the original shares, and 2s. per share on the guaranteed shares, free of income-tax, being 9 per cent. on the former, and 5 per cent. on the latter, which, together with the interim dividend paid on the 1st of February last, will absorb the balance.

It will be observed, on reference to the balance-sheet, that there has been an increase in several items under the head of expenditure, some of which are, however, only casually affected. The amounts charged to carbonizing and wages both show an increase, arising from exceptional circumstances. Rates and taxes are also augmented by the advance on the income-tax, and in the poor and local rates under the new assessment.

The special attention of the directors has been given to improved methods of purifying gas, with a view to securing greater brilliancy and purity, as well as to the utilisation of the products. Additional purifiers and washers are being erected, and other improvements are being gradually introduced calculated to effect economy in manufacture.

The Chairman, in moving the adoption of the report, stated that that was the 25th annual meeting of the company, and, considering the depressed state of trade, and the large number of houses which had been vacant in the town during the twelve months, he thought they might congratulate themselves on being enabled to declare the same rate of dividend as during the last seven years. There had been a small decrease in their gas-rental, but not in the supply to private consumers, which was their great source of profit, as the return upon the gas supplied to public departments was most infinitesimal. It would be seen by the balance-sheet that there was a small increase in the expenditure for coals over the preceding year. That was due to the fact that, although some of the coals used were of first-rate quality, they were not so productive of gas as the directors had anticipated they would be, so that a larger quantity had to be used. The increase in wages was due to the satisfactory fact that the whole of the work connected with the fitting of two machines erected during the year—a new governor for the supply of Morice Town, and a new grubber—had been carried out by their own staff, the contract being for the supply of the machines only. A slight increase under the head of renewals and general repairs had arisen from setting up their new retort-beds, and the retorts in the old house. The whole of these expenses had been charged to wear and tear, instead of capital; consequently the balance was not so large as usual. The capital had been increased by £358 for the two new machines to which he had referred; but, as £298 had been written off for depreciation of works, it stood at £42,780, as compared with £42,839.

Mr. J. C. Radford thought the amount written off very small. He should like to know how much had been lost on the coals.

Mr. Hawker thought the time was come when some change must take place in the arrangement of the company, either by reducing the amount of dividend, or returning to the former price of gas. One of the most noticeable features in the balance-sheet was the fact that in two successive years the dividend exactly absorbed the balance, so that there was nothing over and nothing under; and he could not understand how it could be possible to arrange matters so closely as that. The report he considered to be a laboured document; it proved to his mind that the affairs of the company were not so satisfactory as they had been. It would now, he thought, be admitted that the reduction had been made hastily, and had not produced the access of revenue which had been anticipated. One result was that, if any casualty happened, they had no reserve-fund—nothing to fall back upon except the £3000 of uncalled capital. He should like to know if the amount written off works was calculated upon any principle. During the past year barely £300 had been written off, whereas in the two years preceding it was £753 and £725 respectively. He could not understand those things.

The Chairman, in reply, said that between 400 and 500 tons of coal extra had been carbonized to produce about the same quantity of gas last year as the year before. This showed that the additional expenditure in coals arose entirely from a smaller productiveness in the kind used. The extra cost thus incurred was £250, which was almost precisely the difference between that year's balance-sheet and the one preceding. Mr. Hawker's difficulty about the balance being exactly sufficient to pay the dividend was easily explained. They reserved enough to pay the dividend, and then wrote off the remainder to depreciation of works. In the year before last £753 was written off, but that amount included £200 balance standing over. The result of the operation was this, that whereas in that year they laid new mains, which cost £1000, only £250 of that was charged to capital. If, then, they had no reserve-fund, they had the value of whatever had been written off in their works. During the last 24 years £17,000 altogether had been written off; and their works, having cost £60,000, now stood at something less than £43,000. On an average they had written off £700 per annum; but during the last five years, since the reduction in price, the average had been £608. The difference was not very serious, and the directors hoped and believed they would recover it by the increment of consumption which went on from year to year. Ten years ago their make of gas was 49 millions, now it is 85 millions; and, although in the past year there had been a little falling off, they were in other respects in quite as favourable a position. It would be very desirable to have a reserve-fund if they could; but in addition to the £3000 spoken of by Mr. Hawker, they had £10,000 unexercised borrowing powers to fall back upon. In consequence of borrowing £1000 in June, 1868, they had been enabled to keep a balance at the bank, and had thus saved £20 or £25 in interest on advances, whilst, since the balance-sheet had been prepared, they had been enabled to pay off a debenture of £350. The chairman stated subsequently that the item, "General stores in stock," which stood at £738 in the balance-sheet, should be £1000, the addition being the value of a quantity of old main ascertained in stock-taking. They were thus nearly £300 better off than they appeared.

Mr. Hawker moved an amendment to the adoption of the report, that the dividend should be decreased; but subsequently withdrew it in favour of a suggestion by Mr. I. C. Radford that the directors should be recommended, if the next balance-sheet should not be more satisfactory, to take seriously into consideration the decrease of the dividend or an increase in the price.

The report was then adopted.

Mr. Hawker, in moving the re-election of Mr. R. C. Smith, whom he praised for his attention to the business of the company, though he thought some of the old directors were not the best that could be chosen, again referred to the reduction in the price, and contended that it should not have been made until the company were in a better position, and their staff better paid.

The Chairman, having been re-elected, returned thanks, and defended the action that had been taken. It should not be forgotten that there was originally a consumers company. The difference between their price and that of the Plymouth Company was as great as ought to exist.

Mr. Joll and Mr. Watson were also re-elected directors, the former stating that, if the balance-sheet did not improve, he would take steps both for the reduction of the dividend and the increase of the price.

Mr. W. Rickard was reappointed auditor, and the proceedings closed with a vote of thanks to the board, moved by Mr. Radford, and seconded by Mr. Hawker.

Average Composition and Quality of the Metropolitan Waters in July, 1869.—The following are the returns of the Metropolitan Association of Medical Officers of Health:—

Names of Water Companies.	Total Solid Matter per Gallon.	Oxygen required by Organic Matter, &c.	Nitrogen.		Hardness.	
			As Nitrates, &c.	As Ammonia.	Before Boiling.	After Boiling.
Thames Water Comps.	Grs.	Grs.	Grs.	Grs.	Degs.	Degs.
Grand Junction	19·20	0·069	0·066	0·000	14·0	3·4
West Middlesex	17·81	0·069	0·030	0·002	13·6	3·4
Southwark and Vauxhall	18·07	0·061	0·060	0·000	13·8	3·3
Chelsea	18·17	0·061	0·030	0·000	13·9	3·3
Lambeth	17·97	0·057	0·030	0·000	13·5	3·3
Other Companies.						
Kent	27·60	0·016	0·128	0·000	19·6	5·5
New River	17·70	0·029	0·090	0·000	14·0	3·3
East London	16·13	0·045	0·030	0·000	13·2	3·3

Note.—The amount of oxygen required to oxidize the organic matter, nitrites &c., is determined by a standard solution of permanganate of potash acting for three hours; and, in the case of the metropolitan waters, the quantity of organic matter is about eight times the amount of oxygen required by it.

The average quantity of water supplied daily to the metropolis in the month of June was, according to the returns of the water companies to the Medical Officers of Health, 103,670,995 gallons; and the number of houses supplied was 464,798. This is at the rate of 32·7 gallons per head of the population daily.

Hy. Letheby, M.B.

Gas Lighting in China.—On the 10th of May last the gas-works at the Imperial Custom-House, Pekin, were inaugurated in the presence of Mr. Hart, the Inspector-General of Maritime Customs. After the ceremony, the company adjourned to the residence of Mr. Hart, where breakfast was provided. The health of Mr. R. Ross, late of Tullamore, Ireland, under whose direction the works have been erected, was drunk with enthusiasm, and he was highly complimented on having successfully overcome the difficulties connected with the undertaking.

Influence of Heat upon the Regeneration of Sulphide of Iron.—It is well known that, according to theory, only oxide of iron and sulphur should result from the exposure to air of the oxide of iron applied for the purposes of purifying coal gas; in practice, however, it has been found that peroxide of iron, protoxide of iron, and sulphuric acid are also formed, but in variable quantities. Dr. A. Wagner has instituted a series of experiments, in order to ascertain the influence of heat and moisture upon the regeneration process. One sample of sulphide of iron, prepared by the moist way, was kept for three weeks at nearly 100° Cent., damp, and exposed to air; another portion was kept cold and damp, and exposed, for the same time as the foregoing, to air; while a third portion, under otherwise the same circumstances as No. 2, was kept dry. The result of these experiments is, that heat favours the production of sulphuric acid, while water or moisture does not exert any influence; that moisture and cold (ordinary temperature) produces less sulphuric acid than dryness and cold, since, in the former instance, the occasional watering with cold water, to keep the mass moist, favours a lowering of temperature, which, when no moisture is present, is raised, in consequence of the chemical action; water is, however, absolutely required, in order to reproduce the peroxide of iron, since sample 3 was found to have been only very imperfectly converted into peroxide, more than half of the oxide being found as protoxide. The quantities, as deduced from the experiments, are the following:—Sample 1 (hot and moist)—Upon 1 part of S, ·319 part of SO_3; and upon 1 part of Fe_2O_3, ·1 part of FeO. Sample 2 (cold and moist)—Upon 1 part of S, ·034 part of SO_3; and upon 1 part of Fe_2O_3, ·151 part of FeO. Sample 3 (cold and dry)—Upon 1 part of S, ·085 part of SO_3; and upon 1 part of Fe_2O_3, ·5 part of FeO.

Register of New Patents.

APPLICATIONS FOR LETTERS PATENT.

2151.—Francis George Fleury, of Merrick Square, Southwark, in the co. of Surrey, engineer, for "*Improvements in apparatus for drawing or raising and forcing liquids.*" July 16, 1869.

2152.—Richard Brown Evered, of 28, Drury Lane, brassfounder, and Richard Hurst, of 191, High Holborn, both in the co. of Middlesex,

for "*Improvements in apparatus for raising, forcing, and regulating the flow of water.*" July 16, 1869.

2153.—ALEXANDER ROLLASON, of 123, Pembroke Road, in the parish of Clifton, in the city and co. of Bristol, chemist, for "*Improvements in the mode of extracting ammonia, purifying gas liquor, and utilizing the same.*" July 16, 1869.

2163.—DANIEL NATHAN DEFRIES, of the Metropolitan Works, Euston Road, in the co. of Middlesex, for "*Improvements in gas-meters.*" July 17, 1869.

2186.—THOMAS HOLT, of Rochdale, in the co. of Lancaster, for "*Improvements in apparatus for supplying and distributing disinfectants to closets and similar purposes.*" July 20, 1869.

2203.—JOHN OGDEN, of Manchester, in the co. of Lancaster, mechanic, for "*A combined tap and filter for water and other liquids.*" July 21, 1869.

2233.—THOMAS BARNES, of Whitehaven, in the co. of Cumberland, merchant, for "*Improvements in the treatment of coal for the removal of the sulphur compounds contained therein.*" July 22, 1869.

2240.—JOHN HENRY JOHNSON, of 47, Lincoln's Inn Fields, in the co. of Middlesex, gentleman, for "*Improvements in the joints of pipes and tubes.*" A communication. July 23, 1869.

2249.—RAOUL PICTET, of 4, Rue Jean Goujon, in the city of Paris, France, engineer, for "*Improvements in the building of pumps in general, which permit their working without pistons and oil.*" July 24, 1869.

2264.—BRISTOW HUNT, of 1, Serle Street, Lincoln's Inn, in the co. of Middlesex, gentleman, for "*Improvements in valves.*" A communication. July 26, 1869.

2269.—JOHN HENRY JOHNSON, of 47, Lincoln's Inn Fields, in the co. of Middlesex, gentleman, for "*Improvements in the treatment of nightsoil and other waste products, and for the manufacture of manure therefrom.*" A communication. July 26, 1869.

2276.—THOMAS PARSONS, of the state of Massachusetts, U.S.A., for "*A new and useful mechanism, apparatus, or engine, to be used either in measuring water discharged from a conduit, or for various other useful purposes.*" A communication. (Complete specification.) July 27, 1869.

2277.—DANIEL THOMAS BOSTEL, of 21, Ship Street, Brighton, in the co. of Sussex, plumber, for "*Improvements in what are known as dry earth-closets.*" July 27, 1869.

GRANTS OF PROVISIONAL PROTECTION.

815.—JAMES CARTER, of the town and county of the town of Nottingham, gentleman, for "*Improvements in disinfecting and deodorizing fœcal and excremental matters, and in obtaining manure.*" March 17, 1869.

2081.—JOSEPH BEARD, of Droylsden, in the co. of Lancaster, brassfounder, for "*Improvements in pumps.*" July 10, 1869.

2105.—CHARLES CHAPMAN, of Salford, in the co. of Lancaster, engineer, for "*Improvements in the application of pumps to artesian wells.*" July 13, 1869.

2116.—ISHAM BAGGS, of High Holborn, in the co. of Middlesex, for "*Improvements in the generation and treatment of ammonia.*" July 14, 1869.

2151.—FRANCIS GEORGE FLEURY, of Merrick Square, Southwark, in the co. of Surrey, engineer, for "*Improvements in apparatus for drawing or raising and forcing liquids.*" July 16, 1869.

2152.—RICHARD BROWN EVERED, of 28, Drury Lane, brassfounder, and RICHARD HURST, of 191, High Holborn, both in the co. of Middlesex, for "*Improvements in apparatus for raising, forcing, and regulating the flow of water.*" July 16, 1869.

2163.—DANIEL NATHAN DEFRIES, of the Metropolitan Works, Euston Road, in the co. of Middlesex, for "*Improvements in gas-meters.*" July 17, 1869.

2186.—THOMAS HOLT, of Rochdale, in the co. of Lancaster, for "*Improvements in apparatus for supplying and distributing disinfectants to closets and similar purposes.*" July 20, 1869.

INVENTION PROTECTED FOR SIX MONTHS ON THE DEPOSIT OF A COMPLETE SPECIFICATION.

2276.—THOMAS PARSONS, of the state of Massachusetts, U.S.A., for "*A new and useful mechanism, apparatus, or engine, to be used either in measuring water discharged from a conduit, or for various other useful purposes.*" A communication. July 27, 1869.

NOTICES TO PROCEED.

782.—WILLIAM TURNER CARPENTER, of West Minster, in the Isle of Sheppy and co. of Kent, for "*Improvements in apparatus used in the manufacture of gas.*" March 13, 1869.

1534.—RICHARD EDWARD KEEN, of Red Lion Court, Fleet Street, commission agent, for "*An improved mode of and means for securing panes of glass, more especially designed for street lamps or lanterns.*" May 18, 1869.

1557.—ZEBULON ERASTUS COFFIN, of Newton Centre, in the state of Massachusetts, U.S.A., for "*Improvements in stop-cocks or valves.*" May 20, 1869.

1899.—WILLIAM ROBERT LAKE, of 8, Southampton Buildings, London, consulting engineer, for "*Improvements in blowing and pumping engines, parts of which improvements are applicable to other direct-acting steam-engines.*" A communication. June 21, 1869.

2036.—LEONARD CLAYTON, LAWRENCE CLAYTON, and JAMES SMITH, of Hunslet, near Leeds, in the co. of York, gas engineers and contractors, for "*Improvements in the construction of taps or valves.*" July 6, 1869,

2103.—CLEAVELAND FORBES DUNDERDALE, of New York city, in the state of New York, U.S.A., for "*An improved apparatus for generating hydrogen gas, and for carburetting hydrogen gas or atmospheric air for illuminating and other purposes.*" July 12, 1869.

PATENTS WHICH HAVE BECOME VOID

BY REASON OF THE NON-PAYMENT OF THE ADDITIONAL STAMP DUTY OF £50 BEFORE THE EXPIRATION OF THE THIRD YEAR.

1607.—JAMES ALEXANDER FORREST, "*Improvements in the construction of lanterns.*" June 13, 1866.

1636.—GEORGE HENRI MARC MUNTZ, "*Improvements in the manufacture of certain fittings for gas, steam, and water tubes.*" June 16, 1866.

1787.—WILLIAM CHESNEY, "*Improvements in the manufacture of water and steam cocks or stop-valves, applicable also for other like purposes.*" July 6, 1866.

1788.—ENOCH HARRISON AYDON and EDWARD FIELD, "*Improvements in drawing or exhausting and forcing fluids, and in instruments or apparatus applicable to such purposes.*" July 6, 1866.

1827.—WILLIAM GLASSFORD WALKER and ROBERT FRAZER SMITH, "*A certain improved method of producing illuminating gas.*" July 12, 1866.

1888.—MARC ANTOINE FRANÇOIS MENNONS, "*Improvements in the mode of and apparatus for generating gas for lighting, heating, and other purposes.*" July 20, 1866.

PATENTS WHICH HAVE BECOME VOID

BY REASON OF THE NON-PAYMENT OF THE ADDITIONAL STAMP DUTY OF £100 BEFORE THE EXPIRATION OF THE SEVENTH YEAR.

1876.—JOHN PARKES, "*Improvements in gas-lanterns.*" June 26, 1862.

1891.—ALEXANDER ANGUS CROLL, "*Improvements in the treatment of ammoniacal liquor of gas-works.*" June 27, 1862.

1953.—ARTHUR WARNER, "*Improvements in preparing materials for and in purifying coal gas.*" July 5, 1862.

2023.—PAUL ANTOINE LUCIEN CANONICAT, "*Improvements in filtering water, and in apparatus employed therein.*" July 14, 1862.

Share List of Metropolitan Gas Companies.

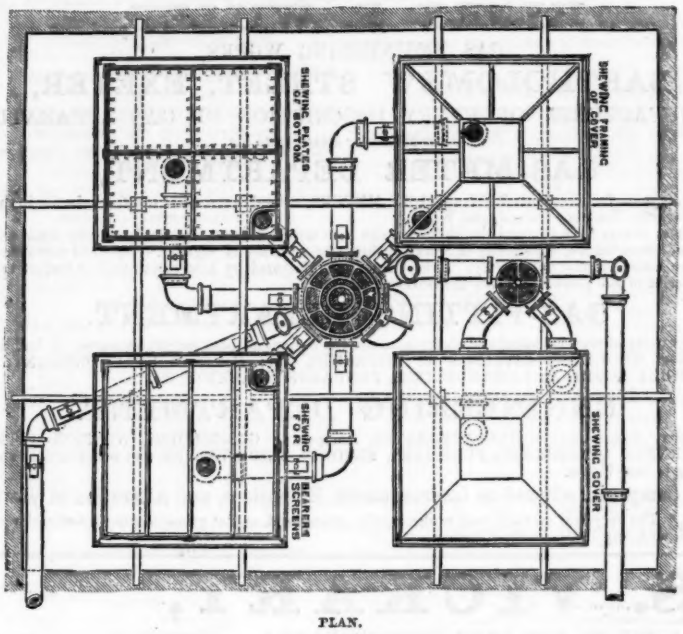
Number of Shares issued.	Amount per Share.	Name of Company.	Amount paid up p. Share.	Dividend p. Cent. p. Annum.	Price per Share.
	£		£ s. d.	£ s. d.	£
8000	10	Anglo-Romano	10 0 0	10 0 0	11 — 12
5000	20	Bahia (Limited)	20 0 0	3 0 0	13 — 14
1000	20	Do., preference	20 0 0	10 0 0	24 — 25
750	20	Do., do., redeemable	20 0 0	10 0 0	20 — 22
40000	5	Bombay (Limited)	5 0 0	4 0 0	4¼ — 4⅜
10000	5	Do., third issue	4 0 0	4 0 0	3¼ — 3⅜
10000	20	British (Limited) (Norwich, Hull-Sculcoates, Hanley, Tunstall & Shelton [Potteries], Trowbridge, & Holywell.)	20 0 0	10 0 0	30 — 31
12000	50	*Chartered*	50 0 0	4 5 0	46 — 46½
6060	50	Do.	45 0 0	4 5 0	41 — 41½
10000	20	*City of London*, A shares	20 0 0	8 0 0	23 — 24
10000	10	Do., B shares	10 0 0	4 0 0	6¾ — 7
9629	10	Do., new shares	10 0 0	8 0 0	11 — 12
17490	25	*Commercial*	25 0 0	10 0 0	35 — 36
20000	20	Continental Union	20 0 0	5 0 0	23 — 24
5213	20	Do., preference	20 0 0	7 0 0	22 — 22½
5000	10	*Crystal Palace District*	10 0 0	10 0 0	13½ — 14
5000	10	Do., preference	10 0 0	6 0 0	12¾ — 13
10000	10	Do., new shares	10 0 0	7 0 0	10½ — 11
4000	50	*Equitable*	50 0 0	10 0 0	64¾ — 65½
4000	25	Do., new shares	25 0 0	10 0 0	32½ — 33
23406	10	European (Limited)	10 0 0	11 0 0	15 — 15⅞
12000	10	Do., new shares (Boulogne, Amiens, Rouen, Caen, Havre, & Nantes.)	5 0 0	11 0 0	7¼ — 7½
20000	10	*Great Central Gas Consumers*	10 0 0	..	11 — 11½
5000	10	Hong Kong (Limited)	10 0 0	6 0 0	8 — 10
26000	50	*Imperial*	50 0 0	10 0 0	70 — 70½
26000	10	Do., new shares	4 0 0	10 0 0	6¾ — 7
26000	12½	Do., new shares	12 10 0	7 0 0	13 — 13½
1300	100	Do., bonds	£100	10 0 0	175 —180
28000	50	*Imperial Continental* (Amsterdam, Berlin, Ghent, Hanover, Lille, Rotterdam, Aix-la-Chapelle, Antwerp, Bordeaux, Brussels, Cologne, Frankfort-on-Maine, Haarlem, Stolberg, Toulouse, & Vienna.)	43 15 0	16 0 0	112 —113

Number of Shares issued.	Amount per Share.	Name of Company.	Amount paid up p. Share.	Dividend p. Cent. p. Annum.	Price per Share.
	£		£ s. d.	£ s. d.	£
400	100	Imperial Mexican (Limited)	100 0 0	nil.	
200	100	Do., new	100 0 0	nil.	
3000	40	*Independent*	40 0 0	10 0 0	51 — 53
3000	10	Do.	10 0 0	5 0 0	7 — 8
3000	20	Do.	15 0 0	7 10 0	15 — 16
7133	50	*London*	50 0 0	10 0 0	66 — 68
5610	25	Do., 1st preference	25 0 0	6 0 0	26 — 28
503	50	Do., 2nd preference	50 0 0	6 0 0	
214	50	Do., 3rd preference	50 0 0	6 0 0	
£18781		Do., 1st preference stock		6 0 0	
£11828		Do., 2nd preference stock		5 0 0	
		Nictheroy, Brazil (Limited)			
15000	5	Malta and Mediterranean (Limited)	5 0 0	3 10 0	3¾ — 4
6000	5	Do., preference	5 0 0	7 0 0	4¾ — 5¼
30000	5	Oriental (Calcutta)	5 0 0	10 0 0	7¾ — 8
30000	5	Do., new shares	1 0 0	10 0 0	1¾ — 1¾
10000	5	Ottoman (Limited)	5 0 0	nil.	1¾ — 2¼
12500	10	Pará (Limited)	10 0 0	7 10 0	8¾ — 9
27000	20	*Phœnix*	20 0 0	10 0 0	26¾ — 27
3600	100	Do., new	35 0 0	7 10 0	36 — 36½
144000	Sk.	Do.	100 0 0	5 0 0	73¼ — 74½
5000	20	*Ratcliff*	20 0 0	10 0 0	23 — 24
	20	Rio de Janeiro (Limited)	20 0 0	10 0 0	25 — 25½
6959	5	Singapore (Limited)	5 0 0	4 0 0	
2000	5	Do., preference	5 0 0	7 10 0	
		Shanghai			
4800	50	*South Metropolitan*	50 0 0	10 0 0	73 — 75
4800	12½	Do., new shares	12 10 0	10 0 0	18¼ — 19
15000	10	*Surrey Consumers*	10 0 0	10 0 0	13¼ — 13⅞
10000	10	Do., new	6 0 0	10 0 0	8 — 8½
9000	4	United General (Limerick)	4 0 0	5 0 0	2 — 2½
10000	10	*Victoria Docks*	5 0 0	6 0 0	
1500	10	*Wandsworth and Putney*	10 0 0	10 0 0	10 — 12
1500	10	Do.	10 0 0	7 10 0	
1819	10	Do.	10 0 0	7 10 0	
1138	10	Do.	5 0 0	7 10 0	
20000	10	Western (Limited) A shares	10 0 0	10 0 0	15 — 15½
10000	10	Do., B shares	7 0 0	10 0 0	9¼ — 10
10000	10	Do., C shares	7 0 0	10 0 0	9¼ — 10
20000	10	Do., D shares	1 0 0	10 0 0	1¾ — 2
8000	5	*West Ham*	7 0 0	7 10 0	7¼ — 7¼
6000	5	Do., new shares	7 0 0	7 10 0	
551	10	West London Junction (Limited)	10 0 0	6 0 0	
520	10	Do., preference	10 0 0	6 0 0	

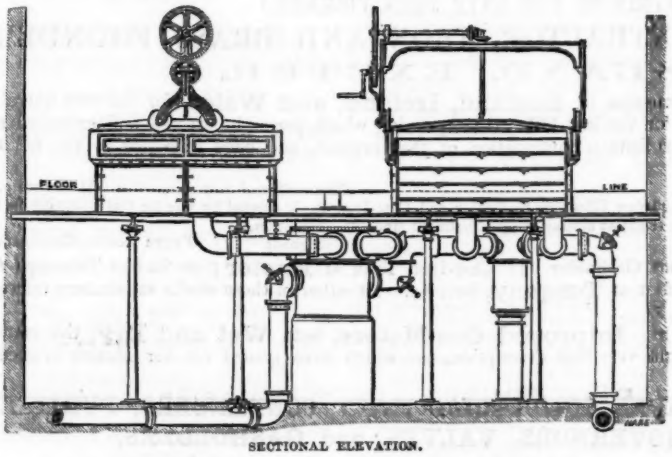
A PLAN & ELEVATION OF GAS PURIFIERS

WITH

COCKEY'S PATENT VALVES.



PLAN.



SECTIONAL ELEVATION.

DESCRIPTION OF PURIFIER ARRANGEMENT.

The plan shows four Purifiers: three of them are worked in rotation by means of a central Valve, so that two are always in use, and the third always out of use for cleaning. By another arrangement of the Valve, either one, two, or three Purifiers may be used together.

The fourth Purifier is used as a guard, with a separate Valve, and is useful in preventing any slightly impure gas, which may have escaped in turning the central Valve, passing in that state to the gasholder.

This system has been found to work well in many gas-works, and in addition to the advantage before stated, it affords a ready and convenient mode of using oxide and lime together for purifying.

By the introduction of a bye-pass, the system is made more perfect, inasmuch as the central Valve, with its connected Purifiers, may be shut off for repair, and the gas passed temporarily direct to the fourth Purifier.

The Valves which are here introduced have now been in use for more than ten years, and have been tested in sizes varying from 3-inch to 16-inch. The increasing demand for them is the best proof which can be given of their satisfactory working and general usefulness.

More than 350 of them have been fixed. They are suited for various parts of gas apparatus, and are especially available for bye-pass connexions. They are also introduced with much advantage for the inlet and outlet connexions of gasholders, and simplify very much the changes where more than one gasholder is in use.

They are durable and easily reground without removal from their connexions, and in a few hours they may be made as good as new after many years wear.

The patentees are prepared to furnish plans, specifications, and estimates, either for the entire construction and erection of gas-works, or for the rearrangement of any part of the apparatus. The Valves are manufactured at the works, at Frome, where also Gasholders, Purifiers, Steam-Engines and Exhausters, Governors, and all other descriptions of Gas Apparatus are made and supplied.

EDWARD COCKEY & SONS.

THE IRON-WORKS, FROME SELWOOD,

March 1, 1869.

TO METER FITTERS.

WANTED, a well-educated experienced GAS-METER FITTER for the test-room.

Apply to J. AND J. BRADDOCK, OLDHAM.

TO GAS COMPANIES.

WANTED, a situation as Working MANAGER of small gas-works. Can lay mains and services, fix meters, fittings, &c. Seven years character.

Address JOHN HANDFORD, Gas-Works, Sheepshed, near LOUGHBOROUGH.

FALMOUTH GAS COMPANY, LIMITED.

WANTED, a Manager for these works. Free house, coal, and light provided. None but competent men need apply, whose character will bear the strictest investigation as to ability, sobriety, integrity, &c.

Applications, enclosing copies of testimonials, and stating salary required, to be addressed to the SECRETARY, Gas Company, FALMOUTH.

SUTTON & HOOTON GAS & WATER WORKS COMPANY, LIMITED.

WANTED, immediately, by the above Company, a thoroughly competent Man (permanent) as GAS ENGINEER and GENERAL MANAGER of the above works, in the county of Chester. A substantial residence, adjoining the works, will be provided rent free, together with gas laid on, and a reasonable quantity of coals for consumption, to be decided by the Directors for the time being.

The salary will be at the rate of £1 1s. per week.

The party appointed will be required to devote his whole time to the service of the Company, and to undertake the setting of retorts, mains, and services, fixing meters, gas-fittings, including smith's work, taking meters, and to furnish a correct account of the quantities of gas consumed to the Secretary. A married man preferred.

Testimonials of recent date as to character and competency to be addressed to me, the undersigned, on or before the 5th of August next.

CHAS. C. DEANE, Secretary.

3, York Buildings, Dale Street, Liverpool.

TO RETORT SETTERS.

WANTED, a Retort Setter for Buenos Ayres, South America. None but a thoroughly competent man need apply.

Address L. WILDE, 15, Brunswick Street, LIVERPOOL.

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WANTED, immediately, a Man to manage small gas-works in Cornwall, where the whole of the duties will have to be performed by the person appointed, excepting in winter, during which a night man will be allowed.

Wages 22s. per week, with house, coal, and light free. Copies only of testimonials and references to be sent to

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FOR SALE, a cast-iron Purifier, 6 ft. by 3 ft. 8 in., with wrought-iron cover, four tiers of wood sieves, and two 5-in. slide-valves, all in good condition, being replaced by larger.

For further particulars, apply to THOS. SIMPSON, Gas-Works, DAVENTRY.

LONDON AND NORTH-WESTERN AND GREAT WESTERN RAILWAYS (JOINT LINES).

FOR SALE, a Set of Three Cast-Iron GAS PURIFIERS, 3 ft. 6 in. diameter by 3 ft. 4-in. deep, with hydraulic centre-valve for 4-in. connexions. May be seen on application to Mr. Bullock, at the Chester Railway Station Gas-Works.

Tenders, sealed and properly endorsed, to be sent to the undersigned on or before the 1st of September next.

J. WAIT, Secretary.

Birkenhead, Aug. 2, 1869.

BOROUGH OF SALFORD.

TO PIPE MAKERS.

THE Gas Committee of the borough of Salford is prepared to receive TENDERS for the supply and delivery on their works of 3000 yards of 2-in., 3000 yards of 3-in., 3000 yards of 4-in., 3000 yards of 5-in., and 2000 yards of 6-in. T.B. Cast-Iron MAINS.

Specifications and any further information can be obtained from the Engineer, at his Office, Gas-Works, Lamb Lane.

Tenders to be delivered, addressed to the Chairman of the Gas Committee, Gas-Works, Lamb Lane, and endorsed "Tender for Cast-Iron Pipes," on or before Monday, the 2nd day of August next.

By order, G. BRETT, Town-Clerk.

Gas-Works, Salford, July 22, 1869.

WOODFORD, ESSEX.

THE Directors of the Chigwell and Woodford Bridge Gas Company will receive sealed TENDERS before the 12th of August next, addressed to the CHAIRMAN, for a supply of good GAS COAL, for One, Two, or Three years, in yearly quantities of about 1200 tons.

To be delivered at the WOODFORD STATION, 300 tons before the 31st of October, and the rest as may be required by the Manager.

TO GAS ENGINEERS, &c.

A Gas Engineering, Gas-Fitting, and Hydraulic Engineering Business to be DISPOSED OF, in consequence of the failing health of the proprietor. A capital opening for an enterprising man with a small capital.

For particulars apply to H. B., care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

EDGE'S Patent for Removing the CARBONACEOUS INCRUSTATION from GAS-RETORTS.

For particulars and terms, apply to E. GODDARD, Sole Agent, Gas-Works, IPSWICH.

CAST-IRON Retorts, Socket-Pipes, with Syphons, and all requisite Connexions, Lamp Columns, Wrought-Iron Tubing, Valves, Street Lamps, Sight Holes, Furnace Doors, Ash Pans, Charging and Coke Shovels, Iron Pails, Coke Barrows, Cross Bars, Fire Pots, Pumps, and Iron Borings.

PURIFIERS, CONDENSERS, and SCRUBBERS erected complete, or the materials supplied; and every description of goods in use by gas-works, in stock, at wholesale prices, at

Mr. LYNCH WHITE'S,
Old Barge Iron Wharf, Upper Ground Street,
LONDON.

GAS-WORKS FOR SALE.

THE Liquidators of the County and General Gas Consumers Company, Limited, are prepared to receive OFFERS for the NORTHFLEET GAS-WORKS. The works consist of retort-houses, with 22 retorts, coal-store, foreman's and meter house, and store-sheds, together with retort-fittings, condenser, scrubber, two 8-ft. purifiers, meter, governor, and brick gasholder-tank and holder, 40 ft. diameter and 16 ft. deep. The gas and meter rental amounts to about £300 per annum, exclusive of a large consumer lately laid on.

Further particulars to be obtained of the Liquidators, Mr. H. P. STEPHENSON, 15, Abingdon Street, WESTMINSTER; or Mr. W. J. WHITE, 33, King Street, CHEAPSIDE.

PURIFIERS FOR SALE.

A Set of Four Cast-Iron Purifiers, 8 ft. square, with wrought-iron lids, wrought-iron centre-valve in cast-iron case, wood sieves, connecting-pipes, and lifting apparatus complete, and nearly new.

If preferred, Cockey's patent centre-valve, or cast-iron sieves, in place of above.

For particulars, apply to G. PORTER, Manager, Gas and Water-Works, CARLISLE.

D. BRUCE PEEBLES,
Gas-Meter Manufacturer,
FOUNTAINBRIDGE
EDINBURGH.

PRICE'S PATENT LAMPLIGHTER is recommended to the notice of Gas Companies and local authorities as effecting a great saving in the consumption of Gas and of public lighting.

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HENRY F. WILLEY,

GAS ENGINEERING WORKS,

BARTHOLOMEW STREET, EXETER,

MANUFACTURER OF EVERY DESCRIPTION OF GAS APPARATUS,

Invites particular attention to his

GAS-METER DEPARTMENT,

Where he manufactures both WET and DRY METERS, several hundred of which are in use in many Gas-Works in England, Ireland, and Wales.

These Meters have received the highest praise from many eminent Gas Engineers, for their excellence of manufacture, superiority of workmanship, and accuracy of register. They are warranted to measure correctly and not to vary. Every Meter manufactured by him maintained in perfect repair for a period of *five years*. All bear the Government stamp.

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A variety of very beautiful and choice patterns and designs adapted for any character of buildings, including MEDIÆVAL FITTINGS for CHURCHES, &c.; Handsome STAR PENDANTS for ASSEMBLY ROOMS, &c.; CHANDELIERS, PENDANTS, BRACKETS, &c.

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Every description of GAS APPARATUS, comprising GASHOLDERS, STATION-METERS, GOVERNORS, CONDENSERS, PURIFIERS, RETORTS, SLIDE-VALVES, and every article appertaining to Gas-Works.

Gas Companies advised on Improvements, Extensions, and Alteration of Works.

*** The very best material and workmanship guaranteed, and at prices bearing a favourable comparison with any House in the Kingdom.

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(ADMINISTRATRIX TO THE LATE JOHN VICKARY,)

GAS ENGINEER AND CONTRACTOR, IRON AND BRASS FOUNDER,

EXE ISLAND, EXETER,

Tenders her best thanks to the various Gas Companies in **England, Ireland, and Wales,** for the very liberal and kind support received by her lamented husband for the last **22 years,** during which period he erected and extended more than **200 Gas-Works.** She respectfully solicits a continuation of that support, and begs reference to the following testimonial:—

Plymouth and Stonehouse Gaslight Company.

Sir,—I have much pleasure in testifying that the 100-foot Telescope Gasholder and Cast-Iron Tank, erected by you for this Company in 1862, has given the highest satisfaction, and never required the slightest alteration or adjustment since its completion.

Mr. John Vickary. (Signed) PETER ADAMS, Chairman.

The late Mr. Vickary also erected a 100-foot Gasholder and Cast-Iron Tank at **Exeter;** an 80-foot Telescope Gasholder and Iron Tank at **Devonport;** a 90-foot at **Torquay,** &c., &c. At either of these works satisfactory references can be made.

C. A. S. V. begs particular attention to her **Improved Gas-Meters,** both **Wet and Dry,** the materials and workmanship of which are guaranteed of the very best description, and which have gained for her Meters so excellent a reputation.

RETORTS, DIP & ASCENSION PIPES, HYDRAULIC MAIN, CONDENSERS, PURIFIERS, STATION-METERS, GOVERNORS, VALVES, and GASHOLDERS,

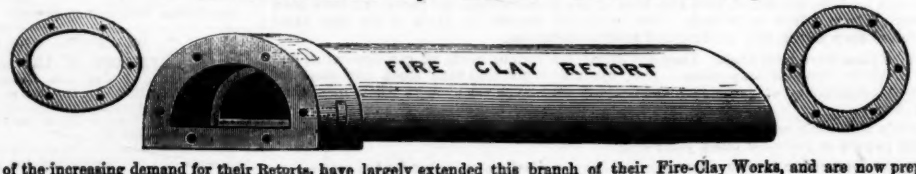
Of any size, and every description of article required in Gas-Works supplied.

Mains, Tees, Connexions, and Syphons, from 2 to 12 in., always in stock, and supplied at Scotch prices.
Clay Retorts and Fire-Goods of every description.
Chandeliers and Gas-Fittings of the most modern designs.
Iron Pipe and Fittings, Service Cocks, &c.

Plans, Specifications, and Estimates for the Erection of New Gas-Works of any size furnished.

THE FARNLEY IRON COMPANY,

FARNLEY, near LEEDS,



In consequence of the increasing demand for their Retorts, have largely extended this branch of their Fire-Clay Works, and are now prepared to execute the most important orders, either for *home* or *export*, with great punctuality.

The Fire-Clay raised from the Farnley Estate (commonly called the Wortley bed) is unsurpassed by any other known in the district, and is peculiarly well adapted for Retorts, Gas-Ovens, and Fire-Bricks; and the F. I. Co. beg especially to invite those connected with Gas-Works, who have not yet used their Retorts, to be good enough to favour them with a trial.

The F. I. Co. generally hold in stock, for immediate supply, Fire-Bricks of every size and kind—Tiles, Sanitary Tubes, Ornamental Terra-Cotta Ware White Facing Bricks, the White, Buff and Salt-Glazed Bricks, &c., &c.

Prices, Drawings, and all other information may be obtained by applying as above, or to

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THROCKLEY,
NEWCASTLE-ON-TYNE.

JAMES NEWTON & SONS,
(Established 1820,)
FIRE-BRICK AND TILE MERCHANTS,
Wholesale and for Exportation,
FALCON DOCK, 78 AND 79, BANKSIDE,
SOUTHWARK, LONDON, S.E.,
DEPÔT for STOURBRIDGE AND NEWCASTLE FIRE-BRICKS, LUMPS, TILES, and FIRE-CLAY, and every Article suitable for
GAS AND WATER WORKS.

HANCOCK'S INDIA-RUBBER GAS-TUBING.

All sizes, from ¼ in. to 4 in. diameter and upwards.
Also,
HORSE SINGEING APPARATUS, best make, with GAS-BURNERS, COMBS, and INDIA-RUBBER TUBING, all complete.
INDIA-RUBBER BAGS for GAS-MAINS.
WASHERS for GAS and STEAM JOINTS.
VALVES (pure solid Rubber) for STEAM-ENGINES.
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FLANGE TUBING, for excluding Draughts and Dust through WINDOWS, DOORS, and GLASS CASES.

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STATION-METERS ANY SIZE,
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NEAR NEWCASTLE-UPON-TYNE,
Manufacturer of Clay Retorts, Fire-Bricks, and every description of Fire-Clay Good

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Plain, Turned and Bored, and Coated.
CAST-IRON RETORTS.
Castings for Gas-Works of every description.
EXHAUSTERS.
LONDON OFFICE: 95, CANNON STREET.

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Patentees and First Makers of Wrought-Iron Tubes.

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Of any extent at Home and Abroad,
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Manufacturers of all sizes of Cast-Iron Main Pipes, by an improved Patent. General Ironfounders, Gas Engineers, and Wrought-Iron Tube Makers.

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Every Description of
GAS LANTERNS & REFLECTOR LAMPS
For Shop Windows kept in Stock.
W. DAVIS, 17, Wells Street, Oxford Street, LONDON, W.
Established 1820.

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GAS"

Is intended to be given by Gas Companies to their Customers. It is hoped the advice it contains may be the means of correcting mistakes and preventing accidents; and also of assisting the Officers in some of the most difficult of their duties.

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CATHELS'S Patent District Dry Gas-GOVERNOR is the only perfect self-acting contrivance for regulating the pressures in the higher levels of a district.

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CATHELS'S Patent Ribbed Gas Main-PIPES cost but about 1d. to 2d. per yard (depending on the size) more than Plain Pipes, and ensure PERFECT GAS-TIGHT CONNEXIONS with the Service-Pipes.

Apply to Messrs. BEGGS & SON, 37, Southampton Street, Strand, LONDON.

W. J. HOLLANDS,
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SOCKET, FLANGE, HOT-WATER PIPES, AND ALL CONNEXIONS; RETORTS, HYDRAULIC MAIN, LAMP-COLUMNS, &c.; AND EVERY DESCRIPTION OF CASTINGS AND WROUGHT-IRON-WORK FOR GAS AND WATER-WORKS, STEAM, AND GENERAL PURPOSES.

N.B.—All goods kept in stock, and supplied at wholesale prices. Estimates given, and orders by post punctually attended to the same day.

JAMES OAKES and CO.,
ALFRETON IRON WORKS, DERBYSHIRE,
AND
WENLOCK IRON WHARF, 98, WHARF ROAD,
CITY ROAD, LONDON,

Beg to inform Gas and Water Companies and the public, that they keep in stock in London all the CASTINGS in general use in Gas and Water-Works, including Iron Retorts, Socket and Flange Pipes, Bends, Branches, and Syphons of all sizes, Lamp Columns, &c., &c.

N.B.—Orders for Cast-Iron Tanks, Girders, Columns, Cylinders, and all irregular castings, will have immediate attention.

CHARLES HORSLEY, Agent.

JAMES M'KELVIE,
CANNEL COAL MERCHANT,
HAYMARKET,
EDINBURGH.

Established 1840.

FIRE-CLAY GAS-RETORTS, &c., CANNEL AND STEAM COALS.

WILLIAM FRASER, Inverkeithing (owner of the Works at which Fire-clay Retorts were first made), having greatly enlarged his works, can supply retorts and other fire-clay goods to any extent.

References can be given to managers of above a hundred Gas-Works whom he supplies.

WILLIAM FRASER ships COWDENBEATH PARROT COALS at Charlestown and Burntisland at 12s. per ton; and HALBEATH STEAM COALS, on Navy List, at 8s. 6d. per ton.

LINTZ COLLIERY COMPANY.
FIRE-BRICK AND RETORT WORKS.

THE LINTZ COLLIERY COMPANY
Beg most respectfully to draw the attention of
GAS COMPANIES, FURNACE BUILDERS,
FIRE-BRICK DEALERS, & OTHERS,
To the superiority of their
FIRE-CLAY GOODS,
Where resistance to heat is of paramount importance, an ample guarantee of which is in the fact of their extensive use by most of the Iron Manufacturers in the North of England.

Not only is the quality of the Fire-Clay inferior to none in the northern Coal-field, but the greatest care is taken in selecting it. It is all hand picked, and well weathered before use.

All orders for
FIRE-CLAY RETORTS of any shape or size,
FIRE BRICKS, &c.,
Will meet with prompt attention.
LAYCOCK'S GARESFIELD COKE.

OFFICES: LINTZ COLLIERY, BURNOPFIELD, Co. DURHAM; AND QUAYSIDE, NEWCASTLE-ON-TYNE.

CANNEL COAL.—The West Yorkshire Iron and Coal Company, Limited, beg to draw the attention of Gas Companies to their Cannel, of which the following is the analysis made by W. Huggon, Esq., F.C.S.:—

Yield of gas per ton	10,296 cubic feet.
Illuminating power rather over	21 sperm candles.
Yield of coke per ton . . .	12 cwt.

The actual working, as reported by one of the largest gas companies in Yorkshire, gives results still more favourable, viz—

Yield of gas.	10,416 cubic feet.
Illuminating power . . .	21·89 sperm candles.
Coke	The same.

We add from the same source the capabilities of the common gas coal—

Yield of gas.	10,080 cubic feet.
Illuminating power . . .	14·41 sperm candles.
Yield of Coke	13 cwt.

COLLIERIES—WEST ARDSLEY, near LEEDS.

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We have now the authority of several of the most eminent Gas Engineers of London in stating that our Coal yields *in practical working over* 10,000 *cubic feet of gas, with an illuminating power of* 16 *candles.*

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OLD WEMYSS CANNEL COAL.—Yield of gas per ton, 12,896 cubic feet; illuminating power, 31·75 standard candles. Port of shipment, Wemyss.

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CANNEL COAL.

MESSRS. GRIFFITHS BROTHERS,
COPPA COLLIERY, MOLD,

Beg leave to call the attention of Gas Companies to the superior quality of their Cannel for gas-making purposes.

This Cannel produces in actual working, in iron retorts, 9200 cubic feet of 32-candle gas, and upwards of 11 cwt. of coke, and in clay retorts will produce 11,500 cubic feet of 25·9-candle gas.

Ports of shipment—Birkenhead or Connah's Quay.

Waggons supplied for delivery by railway to any part of England or Wales.

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MANUFACTURERS OF
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SCOTSWOOD FIRE-BRICK WORKS,
NEAR
BLAYDON-ON-TYNE.

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Manufacturers of all kinds of
GAS AND WATER PIPES,
Branches, Bends, Water-Traps, Tank-Plates, Valves, and general Castings. Also
RAILWAY CHAIRS & SLEEPERS,
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GRIFFIN'S PATENT PERMANENT WAY.
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We are prepared to supply, on moderate terms,
HYDRATED PEROXIDE OF IRON (BOG OCHRE),
Same quality as supplied by us to several of the most extensive Gas Companies, and which has given entire satisfaction.
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BIRTLEY IRON WORKS,
CHESTER-LE-STREET,
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Manufactory for every description of Casting and Machinery for Gas-Works and Water-Works.
Warehouse in London for Cast-iron Pipes and Connexions of all sizes and in any quantity, Scott's Wharf, Bankside, Southwark.
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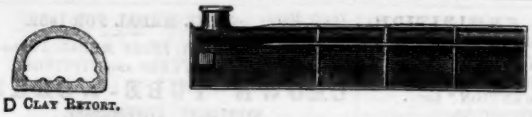
DESIGNS, SPECIFICATIONS, & ESTIMATES FURNISHED.



D CLAY RETORT. D IRON RETORT.

FRASER'S PATENT RIBBED RETORTS.

The IRON RIBBED RETORTS are more durable than plain castings, and retain their original shape to the last.

The "Ribs" strengthen the FIRE-CLAY RETORTS, and by affording an increased heating surface favour the more speedy and perfect carbonization of the Coals.

These Retorts are now in use at some of the London works, and in a great number of the provincial gas-works.

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MANUFACTURERS OF CRYSTAL GLASS CHANDELIERS,
WALL LIGHTS, & LUSTRES FOR GAS & CANDLES.
TABLE GLASS OF ALL KINDS.
CHANDELIERS IN BRONZE & ORMOLU. MODERATOR LAMPS.

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R. D. recommends his Fire-Brick Retorts to Engineers and Managers of Gas Companies; they last from 10 to 12 years.

Iron and Fire-Clay Retorts.	Wrought-Iron Tubes, Water Tanks.
Annular and Pipe Condensers.	Wrought-Iron & Cast-Iron Roofs.
Scrubbers and Purifiers, all sizes.	Gasholders, Single-Lift or Telescopic.
Steam-Engines and Exhausters.	Gas Castings of every description.
Hydraulic Centre-Valves.	Retort Setters and Fitters sent to all parts of the country.
Station-Meters and Governors.	Wood Sieves for Purifiers.
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Lamp-posts and Brackets.	
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GAS AND CONSULTING ENGINEER,
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RETORT SETTINGS, heated by tar without the production of smoke.
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FOUR-WAY VALVES, one of which is equal to three ordinary Valves.
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BREEZE AND TAR FUEL MACHINE.

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"The Author is well qualified to speak authoritatively upon the important subjects to which his pamphlet refers."—*Artizan.*

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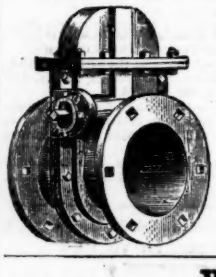
IMPROVED GAS-VALVES
WITH WROUGHT-IRON PINIONS,
From 2 inches to 18 inches, price 9s. 6d. to 12s. per inch diameter.



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These Valves are all proved on both sides to 30 lbs. on the square inch before leaving the works, and are always kept in stock.

VALVES MADE WITH OUTSIDE RACKS TO ORDER.
ALSO,
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PRESSURE-GAUGES, MINUTE-CLOCKS, PHOTOMETERS,
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FITTINGS FOR RAILWAY CARRIAGES AND LAMPS,
AND EVERY DESCRIPTION OF
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ON THE MOST APPROVED PRINCIPLE.

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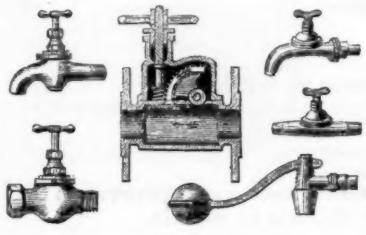

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All the advantages of the ordinary sluice-valve are obtained at much less cost, and the liability to set fast and get out of order entirely obviated.

Particulars of the Quadrant Valve, also of Hydraulic Machinery, High or Low Pressure Cocks, Water-Closets, Gas-fitting in all its branches, and general Plumbers Brass-work, can be obtained upon application.

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Extract from Report by Dr. Letheby:—

"The results have been very remarkable, for they show an average increase of 63 per cent. on the illuminating power of the gas. I am of opinion, therefore, that the invention is of great practical value."

Price 1s. each for Fish-tail Burners.

To be had retail of Gas-Fitters and Ironmongers, and wholesale of

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Terms on application. N.B.—A specimen sent free on receipt of Twelve stamps.

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Gas-Meter, Gas Apparatus, and Gasfittings Manufacturers,

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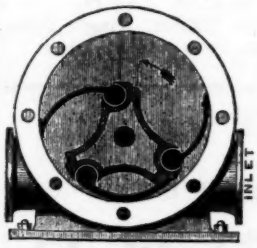

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(From 250 Feet to 200,000 Feet per Hour.)

Also,

ROTARY TAR, OIL, AND LIQUOR PUMPS.

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MANUFACTURERS OF GASHOLDERS, TANKS, PURIFIERS,

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Iron Roofs, and General Iron Work. Mains Supplied and Laid.

S. C. & Son supply every requirement for a Gas-Work, and keep in stock Retort Lids, Cotters, Barrows, Scoops, Bolts and Nuts, &c. &c.

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COMPANY can offer a CANNEL COAL yielding a large quantity of Gas of superior quality.

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J. SUGG and CO., late ALBERT KELLER, Ghent.—The removal of the import duties on Earthenware permitting the entry of Clay Retorts into England, Messrs. Sugg, of Ghent, beg to draw the attention of the Gas Companies of London, and other Cities, to the very superior quality of the RETORTS manufactured by them. They can be made of any size, in one piece, and of any form. The price will be in proportion to the weight, and very moderate in comparison to their value.

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TWENTY YEARS PRACTICAL EXPERIENCE.

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Fire-Clay and Iron Retorts, Double and Single Grooved Brick Retorts, of every description.

Bentley's Improved D Brick Segment Retorts, 5 or 3 in one bed.

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CONSULTING ENGINEER,

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Mr. Penny having had a large experience in the construction, alteration, and management of Gas-Works, begs to inform the Directors of Gas Companies that he may be consulted on all matters appertaining thereto. He also manufactures Gasholders, Purifiers, and all the various apparatus used in Gas-Works, and keeps in stock Retorts and Mouthpieces, Socket-Pipes, Bends, Branches, T-pieces, &c. &c.

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The above Sieves are used by the principal Gas Companies in London and the country. Their utility, durability, and cheapness combined, render them superior to all others.

Testimonials from Gas Engineers who have tested their qualities forwarded on application.

All orders punctually attended to, and estimates given if required.

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FIRE-BRICKS, GAS-RETORTS, AND FIRE-CLAY GOODS

OF EVERY DESCRIPTION.

Orders of any magnitude, for home and exportation, executed with all possible despatch.

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Circulars, 15 in. and 16 in. Ovals, 20 in. by 14 in.

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HIGH-PRESSURE EQUILIBRIUM BALL VALVES

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CAST-IRON GAS-MAIN COCKS,

WITH PATENT METAL PLUGS;

GAS SLIDE AND SLUICE VALVES;

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Large Pattern-Book and Price List of Gas-Fittings, price 7s. 6d., supplied on application.

ROTATORY AND DOUBLE-ACTING GAS-EXHAUSTERS,

with many recent improvements, from 1500 to 150,000 cubic feet per Hour.

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MAKERS OF ENGINES, MACHINERY, and IRONWORK for GAS-WORKS,
efficient and durable TAR, LIQUOR, and SYPHON PUMPS,
GAS-VALVES, with or without Wedges, worked with powerful Worm and Rack,
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SMALL-SIZE EXHAUSTERS KEPT IN STOCK.

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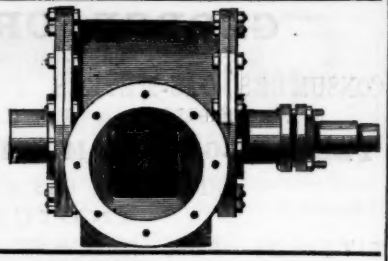

WILLIAM INGHAM AND SONS,

WORTLEY FIRE-BRICK AND RETORT WORKS,

Near

Leeds.

W. INGHAM and SONS, having for many years been extensively engaged in the Manufacture of

RETORTS AND FIRE-BRICKS FROM THE CELEBRATED WORTLEY FIRE-CLAY

beg to call especial attention to their RETORTS, which have for many seasons proved to be unsurpassed in quality by any in the Kingdom, their FREEDOM FROM CRACKS and the ADHESION OF CARBON rendering them worthy the attention of all parties interested in the making of Gas.

The Works are of such magnitude as to ensure the prompt execution of orders to any extent.

Estimates for Setting, or Bricklayers sent when required.

GAS OVENS IN SEGMENTS OF EQUAL QUALITY.

A large stock of Fire-Bricks, Fire-Clay, Terra Cotta, and Drain-Pipes of all sizes kept in London at CHRISTIE & CO.'s Wharf, 64, Bankside, Southwark, where all particulars of Prices, &c., may be obtained.

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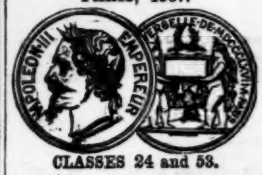

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GAS ENGINEER.

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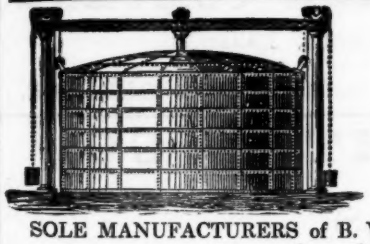
LAMP METERS AND BOXES.

LOWE'S JET PHOTOMETERS CAN NOW BE RATED TO 14 CANDLES.

VINCENT WORKS, VINCENT STREET, WESTMINSTER, S.W.



IMPROVED GAS APPARATUS,

FOR CITIES, TOWNS, VILLAGES, &c.,

INVENTED AND MANUFACTURED BY

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SOLE MANUFACTURERS of B. W. THURSTON'S IMPROVED SCRUBBER, CONDENSER, and WASHER, in use in many of the principal Gas-Works on the Continent.

PATENTEES of the IMPROVED COMBINED PURIFYING APPARATUS, so eminently adapted for Exportation.

ESTIMATES, PLANS, and SPECIFICATIONS PREPARED for BUILDINGS and APPARATUS.

Prospectus, Price Lists, &c., on application.

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REFERENCES TO NEARLY 300 GAS-WORKS.

ORLANDO BROTHERS'

SELF-ACTING DISTRICT GOVERNOR.

Prices, according to size, can be obtained upon application to

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TO CORPORATIONS, GAS ENGINEERS, AND OTHERS.

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GRANGE METER-WORKS, EDINBURGH,

Begs to intimate that he is the ORIGINAL MANUFACTURER of

DRY GAS-METERS IN CAST-IRON CASES.

The Meters are protected by Registration on the 17th of December, 1864, under the "Copyright of Designs Act."

They are much more durable, and at the same time more easily repaired than those in Tin Cases.

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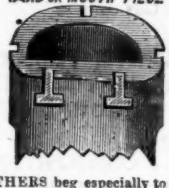
STOURBRIDGE FIRE-BRICK AND RETORT WORKS.



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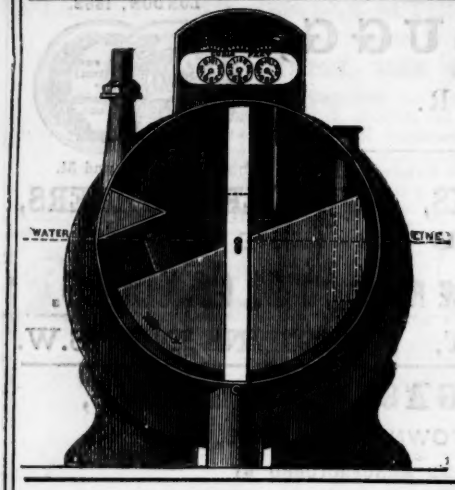

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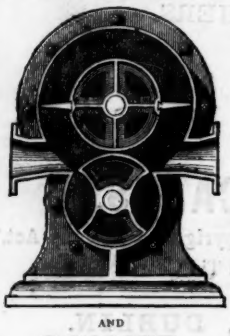

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